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THE AMERICAN
JOURNAL OF PHARMACY

VOL. 102 AUGUST, 1930 NO. 8

EDITORIAL

NOTHING NEW UNDER THE SUN

A hackneyed, irritating phrase, it may seem to the minds of some —yet to others it carries its constant reminder—of the never-ending recycling of human progress—of the dearth of genuinely new thoughts and accomplishments—of the chemists' sardonic word-grin that "matter is indestructible"—and that therefore nothing is new but always a reassembly—always a second-hand item.

To those who study the background of pharmacy, of chemistry, of medicine, and attempt to tie it up to the present, the phrase certainly comes with a fullness of meaning.

For, over and over again, it is seen that so-called modern devices are nothing but ancient performances, ensembled in up-to-date trappings.

Nor, if we believe *Science Service*, are these revampings of the old in make-believe novelties, confined to the fields of the medical sciences, for even our everyday "novelties—our modernities of dress and device, are rebounds from ages long gone."

Professor Magoffin, President of the Archæological Institute of America, tells that "as the ancient world gives up its dead it seems as though the world has nothing new."

This Is How Professor Magoffin Proves the Non-Existence of Novelties.

A foreign firm of world-famed makers of glass proclaimed some time ago the discovery of the method of making perfectly clear yellow-white glass—a few weeks later came the real discovery. In Egypt, a complete table set of clear yellow-white glass of 150 pieces comes unbroken from the excavation of an ancient city in the stratum that dates from the second century B. C. Behold, a glass idol shattered!

In clearing away the old wall on Acropolis Hill at Athens, which Themistocles about 500 years B. C. had to build very hurriedly, using anything that came to hand, there was found in the debris two marble slabs with sculptured reliefs on them. One of them shows a fine fight between a dog and a cat. But the other portrays the start of a real struggle. In the center of the sculptured slab two young men stand, hockey sticks in hand, the ball on the ground between the sticks, and the referee about to give the signal for the game to begin.

Our boys whip tops at the regular top season. The boys in ancient times did not know that sport, we may be sure. So we thought, until a few years ago. In a museum in Baltimore there is now an ancient Greek dish that was painted and fired some 2500 years ago. In the center of its bowl a painted design shows two persons, a man and a boy, and some sort of object on the ground between them. The

man holds a short stick, from which hang five little strips painted black. They represent leather. The object on the ground is a big wooden top. The man is whipping it, and it spins there as nicely as any top of the most modern make.

But of course the ancient Greek or Roman boy did not know the luxury of that greatest juvenile necessity, a pocket knife. Didn't he, though? There have come to many of our museums in the last few years from the recent excavations, scores of ancient pocket knives, a good many with the blades of bronze still in them. Bronze will cut as sharply as steel, but it must be honed or stropped more often. If, however, our knife blades are a bit better than those of two or three thousand years ago, the handles of bone and ivory on the ancient knives are beautiful, whereas ours are ugly. One handle of ivory is carved to represent the figure of an Atlas, another is like a marble table leg, another represents a full-armed gladiator, another is like a fish, and so on, for scores of different handles of beautiful shapes.

A half century ago a fortune was made by the invention of the safety pin. Some ancient person will rise from the dead one of these times and sue for accumulated royalties. The safety pin in bronze, in silver, and in gold, with pin, bow, catch, and all—except that all the thousand varieties are artistic in shape without losing safety value—are now by the hundreds in every good museum, and many of them go back in date a thousand years more B. C. than we are since.

But of course we beat those ancients in sewers. If digging them up and keeping them in public view is the criterion, we certainly do. The excavations of Sir Arthur Evans at Cnossus in Crete laid bare a sewage system of some 2500 years or so B. C. about as good as ours of today. The lead water pipes in Pompeii an Ostia are only 2000 years old. Yet in one of the houses in the Street of Abundance at Pompeii which was excavated only last summer, you can turn on the ancient faucet, just like ours, and the fountains will play for you from the same openings through which the water sprayed or shot two millenia ago.

It begins to look as if we do nothing that they also did not know how to do. They shot craps, they played checkers and parchesi, they had perfect form in leg action in the sprints and the distance races, they threw the discus, they used knuckles instead of gloves in boxing, they wore clothes as short, as brilliantly colored, and as diaphanous as any that show off the dancer, the actress, or the debutante of today. Icarus had no harder luck than many an aviator of this day of grace; Tantalus was just as thirsty as any modern American. Many a winning charioteer drove as many races as any modern jockey ever rode and made as much money; the ancient gladiator had even more lady devotees than the modern prize fighter.

And Professor Magoffin concludes his observations by asking whether it was Solomon who said there was nothing new under the sun? To which we react that wise Solomon knew that there was nothing new *under* or *over* the sun.

IVOR GRIFFITH.

ORIGINAL ARTICLES

HEAT AND COLD

By Adley B. Nichols, Ph. G., Phar. D., B. Sc.

Assistant Professor of Operative Pharmacy, Philadelphia College of Pharmacy and Science.

AT THE OUTSET, let us correct our title, or correct the common idea that heat and cold are two distinct entities, for this is wrong. There is only one true unit of measurement, that is, upward from absolute zero, of which we will hear more later. Cold is merely a word used to designate the relative condition of a substance when it has less than the normal intensity of heat. To render a body cold, we do not add cold to it but we take the heat away. Heat is a relative matter for we might take a container of liquid air at 320 degrees below zero and find it would boil on a cake of ice and even more actively if a piece of ice were placed in it. To us the ice is cold but in terms of the liquid air it is hot. Heat and cold are usually reckoned by our sense of touch—c o l d—cool—warm—warmer—hot and so on, but the sensation we have is dependent on the conductivity of the article we touch. For instance, in a cold room where we know that all items must have the same actual temperature, we walk on a soft rug and it feels warm to our feet, but we step off onto the hardwood, or, more strikingly, a tile floor, and we react immediately to the change, saying that the tiles are much colder than the rug. Or we touch the papered wall and next a glass door knob, then a steel grate, and our reactions are the same, each in turn feels colder, but why? It is a matter of conduction, the ability of an article to conduct heat from our bodies when in contact with it. We all know that a teaspoon in a cup of hot tea becomes hot itself very quickly. It is a good conductor, while we could take a stick of wood, light one end of it, and hold the other end in our hand until the entire piece was nearly consumed before

WHAT IS IT?

Adley B. Nichols, Ph. G.

we would feel the heat. In other words, the wood conducts the heat very poorly. It is then the action of the good conductor taking heat from our hand when we touch it that makes the article feel cold to the touch.

Heat is generally considered as the state or condition of molecular vibration, or the violent agitation of molecules of matter. Matter is composed of extremely minute particles called molecules, which however have definite size and weight for each definite substance. It has been estimated that the molecule of water has a diameter of about one forty millionth of an inch. Though these molecules are small in size, their velocity, even at ordinary temperatures is very great. In air, in which the molecules dart about in straight lines until they encounter other molecules, they attain a speed of 1470 feet per second even at freezing temperature. The average length of their path between two encounters is about 1/277,000 inches and the number of molecules in a cubic inch of air is 443 million, million, million, thus each molecule experiences about 5,000,000,000 collisions a second and one wonders from this if they are forced to carry compulsory accident insurance. As heat is applied to a substance, these molecules expand, increase their speed and their vibration, and the greater their activity, the greater the temperature. Temperature may therefore be considered as the intensity of heat or may be thought of as the pressure of the heat in a body just as a steam gauge records the pressure and not the total quantity or volume of steam. Our teaspoon in the cup of hot tea finds its molecules at the tip of the spoon set in motion and this motion is passed on and on eventually reaching the far end of the spoon. Agitation of a substance speeds up vibration of the molecules and produces heat. We have all probably experienced this in attempting to break a soft wire in two by bending it, or have found a nail become greatly heated by being hammered. Thus heat is found in all forms of energy and may be regarded as the basic energy and all energy may be measured in terms of heat.

When one goes out on a cold day and is not dressed warmly enough, the cold stimulates the skin. The nerves then convey this stimulus to the brain and impulses are sent out which cause you to shiver. Shivering is muscular work solely for the purpose of producing heat. In order to stop it, we substitute some other muscular activity and walk briskly or run, or perhaps we turn back for heavier clothing which is to keep in the heat of the body, and not, as we

often think, to keep the cold out. More food is required if we do not use the heavy clothing and exercise heavily.

SOURCE While we may consider several sources of heat, the sun is directly or indirectly our source of supply. It is generally considered that the sun has a surface heat of from 10,000 to 15,000 degrees F. and gives out annually some 120,000,000,000 tons of heat. This of course goes out in all directions and our earth only receives about 1/2,000,000,000 part of this enormous supply. The rest goes to other planets like ours or passes off into space. The heat of the sun on our lakes, rivers and oceans takes up water, carries it over the land, clouds are formed, and the moisture is dropped to earth where it cares for vegetation, which in turn makes animal life possible, or produces coal and peat after millions of years. Brooks and rivers are again formed and by harnessing these man obtains electricity and mechanical power and energy, and so the endless chain goes on. The sun's rays have been harnessed in many ways and have been made to run boilers in Egypt and Texas and bake ovens have been prepared in a similar manner.

The internal heat of the earth produces another most interesting question, and it has frequently been suggested that the day will come when man will harness the enormous amount of heat and energy encased in this globe of ours and have it do all his work. The actual temperature of the center of the earth is only a matter of conjecture of course, for man has barely been able to prick through the skin so to speak. Our present knowledge and calculations have been made either at the natural open pits such as volcanoes and the pits in our own Yellowstone, where it would seem that something very interesting must be very near the surface, or through the deep mine shafts which have been sunk in various parts of the world. Based on the average rise of temperature in deep wells about 10 degrees F. in fifty-five feet the earth's center would be 443,000 degrees F. which is ridiculous for the sun is only 10,000 to 15,000 degrees F. and that is outside temperature. In South Dakota the temperature is found to increase 10 degrees F. in every forty-five feet and in one of the world's deepest wells in California at 8000 feet a temperature of 230 degrees F. is recorded or 18 degrees above the boiling point of water. According to these calculations we are indeed skating on thin ice and twenty to thirty miles would certainly produce something in-

teresting. However hot the center of the earth is, the crust which surrounds it to a depth of supposedly sixty miles together with a rocky layer beneath of 800 miles, prevents this heat from escaping to any appreciable degree. After this double layer there is supposedly a central core of 3000 miles composed of iron and nickel and this is calculated to be within the molten state which might be somewhat under 3000 degrees F.

Another theory of the temperature increase in the earth's crust is that it is not necessarily due to the internal heat of the earth, but to radio activity, chemical activity and so on, again bringing to mind our reference to the activity of the molecules in producing heat and energy.

TRANSMISSION OF HEAT

Heat is transmitted by one of three agencies—conduction, convection or radiation. Conduction is that agency which is propagated along its own molecules such as we had in the case of our teaspoon. As we noticed in the case of the spoon and the stick of wood we find a great difference between this conduction power in various solid bodies. Liquids are poor conductors, as we can observe by heating water from the top until it actively boils while the bottom of the container will be quite cold. And finally, gases are the poorest conductors of all. By convection, we mean that power by which heat is carried and distributed through the mass of a fluid body by the actual motion of its own particles, as in the heating of water, or as the air at the top of a room is heated by the ascending currents of warm air. And thirdly we have radiation, by which energy is transferred by etherial waves or vibration and does not depend on the presence of matter, not even air, as is instanced in the radiation of the heat from the sun to the earth through vacuum. These radiated waves are not deflected from their course by air currents, or winds. Possibly you have been forcibly impressed with the advertising medium used for radiant electric heaters, when as you are walking down the street you suddenly pass an intensely hot beam and turn to find a heater focused directly across your path through a store window. No matter how windy the day or how cold, the heat waves are still there. We see the sun's rays shining brightly through a window, but we must be directly in those waves to feel the heat. These waves of radiant energy are not converted into heat until intercepted by some material body. Black ob-

jects are recognized as good absorbers of heat and later we shall see that this principle is used in measuring heat. However, good absorbers are good radiators and where we have hot objects like stoves and steam pipes, we find they lose much of their heat by radiation and the blacker the object the more it will lose—therefore stoves and steam pipes should be black if they are intended to give out heat, but hot air pipes, cooking utensils, etc., should be bright, tinned or nickled, in order to lose as little heat as possible. For kettles on a gas stove, however, it makes little difference whether they are bright or black as heat comes to them by direct contact with the hot gas. Accordingly, radiators in our homes would be more serviceable if they were black or at least not the usual silver finish which is generally found.

Climate or weather is really not much more than a story of heat in varying forms, for winds, storms, and daily temperatures at all times of year are the direct result of heat. Radiated waves from the sun strike the earth, cause convection currents which pick up moisture, transforming it later into clouds as cooler upper currents are reached, the clouds break and we have our rain or snow as the season may prescribe. We have our hot days of summer and our cold days of winter, which to us are enormous extremes, but are they?

ABSOLUTE ZERO

Referring for a moment to our explanation of heat as a motion of molecules, we recall that the greater the motion the greater the heat developed. Conversely, the slower the motion the less heat, and if there were no motion, there would be no heat. One of the effects of heat is to expand a body and likwise when heat is taken away contraction occurs. It is found that when a perfect gas, when confined in a vessel at 0 degree C. is cooled 1 degree C., its pressure is observed to decrease 1/273 of the pressure at 0 degree. Therefore if the temperature were lowered 273 degrees C. below 0 degree C. there would be no pressure exerted by the molecules, in other words no motion and consequently there would be an absence of all heat. This point is known as absolute zero as compared with 0 degree C. and 0 degree F. of which we will hear more later. On the F. scale, absolute zero would be at —459.60. Now then, when we consider this scale we find the surprising fact that we live and exist in temperatures barely above the bottom of the scale. Our Philadelphia temperature rarely

reaches 0 degree F. on the one hand, or does it often exceed 100 degrees, the actual extremes of the weather bureau being 6 degrees below zero in 1899 and 106 degrees in 1918. The coldest temperature produced by nature was recorded in Siberia at 92 degrees below zero, while the highest on record was in northern Africa at 136.4 degrees. Yet extreme as these seem to be to us they only represent a range from about 368 degrees to 596 degrees above absolute zero, while the sun looks down on us with an external temperature of about 15,000 degrees and an internal temperature calculated at some 50,000 degrees, and other stars range upwards of 1,000,000 degrees which must be much hotter than that proverbial orthodox abode of the morally condemned.

Balloon flights above the earth have shown extreme degrees of cold, the record being approximately 71 degrees below zero and at about seven miles the temperature apparently remains constant or increases irregularly above that point for some distance. Recent tests made in France raise the question as to whether at about twenty to thirty miles above the earth the temperature may not be 212 degrees F. or the temperature of boiling water.

MAN-MADE EXTREMES

While nature's temperatures come within a narrow range, man himself has been able to produce some very interesting extremes. Pressure we find develops heat, as anyone who has pumped up a flat tire can verify, and conversely the release of that pressure produces the opposite or a cooling effect. We find this reaction taken advantage of in our present-day refrigeration systems whereby ammonia gas for instance is alternately compressed and released with a result that brines on the exterior of the pipes carrying the released gas are chilled and refrigeration is produced. The latest and increasingly popular application of this principle is found in the making of "dry ice" as it is called. This is simply a case of releasing carbon dioxide gas from a cylinder under high pressure, into a suitable container to collect the snow that immediately forms. The temperature of this snow, or "dry ice," is about 109 degrees below zero which accounts for the "rock-like" bricks of ice cream we sometimes find packed in dry ice, while the ordinary temperature for ice cream is only a few degrees below zero.

Scientists are carrying out this principle in low temperature laboratories to even greater extremes, the low temperature laboratory of the Bureau of Standards at Washington having produced liquid hydrogen at 430 degrees below zero while at Leyden, Holland, not only liquid helium has been produced at a temperature of 458 degrees below zero, but this liquid has just recently been solidified under a pressure of 150 atmospheres. This temperature is within one and one-half degrees of the absolute zero and the work is most exacting as materials must be purified and repurified to the highest degree and even then there are hundreds of possible causes for the interruption of the experiment.

Near this absolute zero strange things occur. All the ideas of electrical resistance are upset. Metals which because of high resistance are poor conductors become excellent ones when placed in a bath of liquid helium. In a ring of pure lead connected to a current of electricity, the charge passed around the ring and continued to do so long after the wires were removed, and would have lasted for several years, if the supply of helium could have been maintained.

What this temperature might do to us is left entirely to the imagination but there are possibilities, as shown several years ago when liquefied air was first discovered. One New York doctor had a cold well in which patients were entirely immersed except for the head, at a temperature of from 110 to 160 degrees below zero for varying lengths of time, and by this means he was able to remove cancer, bunions, corns, warts and superfluous hair, while another doctor lost chronic indigestion by the treatment.

The question as to whether life could exist at absolute zero or in its vicinity is an open one of course but we know that various forms of low animal life are now able to exist at extremely low temperatures. A fish for example may be frozen alive and restored to normal without injury and it is reasonable to assume that a fish could be subjected to the extreme cold of liquid air, but in the restoration to a normal condition the thawing would have to be very slow, otherwise the fish would burst to pieces.

Man has also reached many high temperatures the highest probably being in the nature of an artificial star, through a most fascinating experiment conducted at the Mt. Wilson Observatory. This was accomplished by exploding extremely fine wires by a powerful electric discharge. The wires, finer than a hair and several inches long, were

placed in a circuit with a large condenser which was heavily charged. The circuit was closed and enormous power passed through the wire, just as though the whole power output of a generating system big enough to light a city was concentrated into the wire. There was a blinding flash and a loud report of ear-piercing sharpness and the wire was gone—not even dust remaining. That is all that could be seen by the observer, but by photographing the explosion reflected in a rapidly revolving mirror, it was found that the wire was almost instantaneously converted into a thin filament of incandescent vapor which expanded in all directions until it had swollen to the diameter of an inch or so and then disappeared. This process took perhaps 1/25,000 of a second and calculations based on the known properties of the iron wire showed that it melted in about one-quarter of a millionth of a second, began to boil in the next one-quarter and was completely evaporated before 1/1,000,000 of a second had passed. The vapor at this time would have had a temperature of nearly 3000 degrees exerting a pressure of about one-half ton per square inch. Such a mass would then be ionized and would conduct the current from the condenser discharge and therefore become still hotter. How hot is the question, but this could probably best be determined by the amount of light it gave out, which showed it to be brighter than the sun itself, at least 20,000 degrees C. to 36,000 degrees F. Experiments such as these are made in calculating the conditions of the stars as shown by photographic records.

A temperature of 7677 degrees F. was recently attained by English scientists with a combination of manufactured gas and oxygen.

These temperatures may be more thoroughly appreciated when we make comparisons with such general temperatures as the boiling point of water at 212 degrees F., the melting point of lead at 600 degrees F., the dull red heat at 1175 degrees F., the oxyacetylene flame at 5072 degrees F. and the electric arc at 6300 degrees F.

BODY REACTION TO HEAT

Let us now look into the reaction of our bodies to heat. Normally, body heat for man ranges from 97 to 100 degrees F. with the average of 98.6 which is the figure usually taken as normal, although this varies in individuals and also varies with age. This uniform temperature of the human body is controlled by a most marvelous mechanism and all practically automatically as far as any thought on our part is con-

cerned. The food we eat is changed by combustion into heat just as similar combustion changes coal into heat for our homes. Our muscles by their action are constantly producing heat. The heart and respiratory organs are likewise producing their share by their continuous action. All this heat in a normal properly functioning body is lost as soon as it is produced and thus our body temperature remains unchanged. The harder we work, the more action we give our muscles, the more heat is produced and this is automatically given off as fast as it is produced. This same thing occurs in boiling water for water boils at 212 degrees F. and no matter how much heat we apply after it begins to boil, it becomes no hotter, but the extra heat is given off by the actual boiling. The body loses about three-quarters of its heat through the skin by conduction, convention, radiation and perspiration, while most of the balance is lost through the action of the lungs. No matter whether one is with Byrd at the South Pole, or in the middle of the Sahara, the thermostat functions perfectly, closing the pores to retain the heat in one case or opening them wide to eliminate the excess in the other, just as we open and close the dampers on our furnaces in our homes to get the same effect from them. Is there another instrument anywhere so delicate and so constant, able to give control under such extreme odds? Naturally, such a mechanism must be protected. Total prevention of respiration through the skin would result in complete collapse, as happened years ago during a religious fete in Italy where a child was covered from head to foot with gold leaf to represent an angel. In a few hours the child was dead, people interpreting the case at that time as one of divine displeasure, but today we know that a modern doctor would have scraped off the gold leaf and saved the child's life.

The opposite effect of too little evaporation and loss of heat from the skin is also found. In hot weather more heat may go to the body than it is able to give off, particularly in the case of high temperature and also high wind which keeps the skin perpetually dry and allows body temperature to rise to a point where it endangers life. That is why we usually find dry skin a forerunner of sunstroke. Then again, cool the body one degree or so below its normal temperature and a sense of chill is immediately manifest, the system reacting and shutting off perspiration. Extended loss of heat depresses the tissues so that death results. What is called "death

from exposure" is really due to heat loss. An underfed, poorly clothed and perhaps intoxicated person falls asleep out of doors in a frosty night; so much heat is lost that the heart and nervous system never recover and the person never wakes. The lowest temperature recorded in man, 80 degrees F., has been under such conditions.

FEVER

When the body is unable to regulate its own temperature within fairly narrow limits the body machine is usually in need of repairs of some sort. When the temperature of our automobile engine reaches a point abnormally high we know that there is something wrong with the water or oil circulation. When the body temperature is raised, the blood circulation may bring about the same conditions and very often the individual loses his bearings too.

As someone recently wrote on this subject. "We often want to be someone else, but only mentally deranged become that.

"However, with fever of 102 we become someone else but not the one we always hoped to be. This fever person is forced on us, not chosen. He is not superior to the normal self but inferior—he is quite different than the normal self.

"Good and evil is a matter of total indifference to him. He doesn't care whether he is rich or poor, no hatreds disturb him—Those who were his loved ones are strangers now—His enemies are neither more or less—News of his ruin or death of his friends does not disturb him for every time there is a rise in temperature life becomes less interesting and death less terrifying and actually comforting."

We may place 111 degrees F. as the highest internal temperature compatible with life. At this temperature permanent injury is certain because the nerve cells are definitely changed by heat coagulation at about 110 degrees F. and the heart probably fails at about 108 degrees to 109 degrees F.

Of course external temperatures are quite another thing. Experiments have shown that man is able to withstand temperatures of 250 degrees F. for fifteen minutes without ill effects or serious rise in body temperature, while a steak exposed to the same environment was cooked in thirteen minutes. At first thought we might conclude from that that as a delicacy for a pack of cannibals we would be rather tough, but it must be remembered that the ability of the human body

to withstand this high temperature depends on the efficiency of the body in keeping cool by evaporation, a feature also enjoyed by the steak when it was a cow grazing in the sun.

HUMIDITY

We cannot pass this phase of our subject without consideration of another very important angle. The question of whether or not it is hot enough for us is not entirely one of temperature as indicated by the thermometer, for in Philadelphia for instance we would undoubtedly say, "Yes, too much so," while one from the southwest would tell you that there was no special discomfort and no wilted white collars at 110 degrees in the shade, and yet both would be right. Cold enough and only at 32 degrees or so would bring forth the same answer from the east, while one from Montana will tell of not suffering at 25 degrees below zero.

"NOT THE HEAT—THE HUMIDITY!"

The answer lies in the condition of the air known as relative humidity, something that is rather vague to most of us because there is no simple method of measuring it, while on the other hand we find thermometers everywhere.

As a matter of fact desert air in Arizona may contain as much water vapor as that in Philadelphia, but at the higher temperature it does not make itself known. When air is saturated with water vapor we find it extremely oppressive, particularly at high temperatures. Air at the same temperature but with only one-quarter the amount of water would be most delightful and exhilarating. Denver, Colorado, is considered as a summer resort and Washington, D. C., anything but that, and yet the two temperatures are about the same, but Denver has a relative humidity of 52 per cent. in August while Washington has 77 per cent. relative humidity meaning the ratio of total moisture in the air compared to what it could actually hold at that temperature or the saturation point.

As the cooling ability of the body depends on evaporation to be effective, when relative humidity is low, perspiration evaporates rapidly and the body readily cools to the proper temperature. When relative humidity is high, the air is near the saturation point for

water vapor and perspiration collects on the skin and dries slowly, if at all, and we speak of the weather as sticky.

In cold weather high relative humidity is again disagreeable, this time because moisture penetrates the clothing and makes it a better conductor of heat, with the result that the body cools faster and we say the cold is penetrating and we are chilled to the bone.

This humidity question enters our homes, too, and is responsible for much of our winter sickness, colds, catarrh, bronchitis, chapped hands and face, etc. When our rooms are dry, the mucous membranes of our noses and throats become dry and parched and splendid opportunity is given to the germs of cold and influenza to take hold. Heat greatly increases the capacity of a given space for water vapor. For instance, it requires about four times as much water to saturate the air at 70 degrees as it does at 30 degrees and increasing the temperature from 70 degrees to 80 degrees increases its capacity for moisture about 50 per cent. Superheating, therefore, is very objectionable and actually dangerous. It is quite a task to supply the necessary water vapor to give the best results, but the problem can best be solved by maintaining lower temperatures. Instruments for determining this relative humidity will be discussed later but we might mention here that a temperature of 68 degrees F. with a relative humidity of 50 per cent. is not difficult to approach in the home where plants, radiator pans, wet towels, etc., may be used to give the desired moisture and the reaction one attains from such a combination is very invigorating. We must not consider this 68 degrees in the same terms as we have probably been accustomed to consider it for we find it is not cold, as we have supposed, when the humidity has been properly controlled in connection with it. Dry air and high temperatures definitely tend to nervousness and restlessness, inability to concentrate, irritability, drowsiness, loss of appetite, low spirits and lower body resistance, while a lower temperature with controlled humidity eliminates all of these and we are exhilarated and enjoy our work, our play and our leisure hours to the fullest extent, at the same time raising our health level to a much higher degree.

Further references might readily be made to this question and the many uses to which it is placed in practice but this subject will undoubtedly be thoroughly covered in one of the lectures soon to follow in this series.

NEED FOR TEMPERATURE MEASUREMENT

Let us now turn our attention to the methods of measuring the degree of heat or temperature, and the many and varied instruments with which this is done. We might first look into the question of why it is necessary to measure temperatures, in other words the application of heat to our daily lives.

THE HUMAN BODY THERMOSTAT

We have already considered the temperature of the human body and have discovered what happens when the normal body temperature fluctuates. There is surely no need to go further into that question for we all know how the doctor watches the temperature chart which tells the story of the sick one so vividly. He has long ago given up the old idea of trying to determine temperature by placing his hand on the patient's forehead.

WHY THE WEATHER?

We have also mentioned the weather which we found to be controlled primarily by heat. And is there anything more talked about? Is this not one place where all humanity meets on a level? The millionaire asks the milkman in the morning what the temperature was at sunrise, and the policeman forgets his duty long enough to speak of the intense heat or biting cold and so on. We have probably been discussing this question only recently and claiming that we are using more coal this winter, which may be quite true, but it is probably the fault of the coal, for actual figures show that the average temperature of the first few months of this winter were above those of last year. And over extended periods these same records show that the seasons remain pretty uniform from year to year. That our perspective in this regard changes was very nicely shown by the old timer who was discussing winters as he knew them. He remembered well, when as a boy, he had waded through snow up to his crotch, but he also realized that his crotch at that time was only about "so high."

IN THE KITCHEN

What part does temperature play in your everyday life, in your kitchen for instance? Your first thought, of course, is of your stove which is a direct means of providing heat for the room itself, or it boils water for your dishes and clothes but primarily it is used to cook your foods for your daily meals and surely you know what happens

when the temperature is not controlled there. Puddings boil over, cakes burn, peas stick to the dish because the water boiled off and the heat became too severe. But even the stove itself is a product of temperature control, from the iron and steel which enters into its makeup, to the pretty green enamel, placed there by a carefully regulated baking process. The aluminum and the agate pans you use with the stove, the kitchen table with its enameled top, the china in your cupboard, the paper lining the shelves, the very shelving and the food itself from pasteurized milk to all the canned goods, are all possible and uniformly excellent because of temperature properly controlled. The California fruits in your refrigerator, the eggs certainly, the refrigerator itself, the linoleum of the floor, the curtain at the window, the electric light and the chain by which it is suspended, the wall switch and the light cords. As a matter of fact is there anything we can mention that does not link itself up definitely with temperature control? The gasoline for your automobile is obtained purely through temperature control, and is set off to propel your car by the same means. The tires your car runs on, the upholstery, windshield, chassis, and in fact every part of it is temperature controlled. The gas for your cook stove is all prepared by proper control of temperature. Your baker does not burn his bread or cakes because his ovens are properly and automatically controlled. Your milk is safe to drink because it has gone through a pasteurization process, which is just one of temperature control. Your green houses are of course under temperature control, refrigeration plants, chemical manufacture, confections, glass manufacture, paper industry, steel, cement, soap and so on, naming what you will.

Orange groves are protected today by an alarm system which tells the owner when dangerous temperatures are approaching so that he may be able to start his smudges and protect his groves.

The thermometer is being investigated now as a divining rod to locate oil deposits and certain minerals by relying on the suspected fact that the temperature rises in the vicinity of oil, coal, salt, etc.

A Kansas chemist has recently made synthetic diamonds from iron filings and sugar liquefied under a temperature of 2500 degrees C. and then plunged into ice cold salt water. And so it becomes an endless chain and one wonders what man will be doing with the temperature at his command in another hundred years.

DEVELOPMENT OF THE THERMOMETER

Almost every thermal phenomenon has been utilized for temperature measurement, from the simple expansion, normally and under pressure, of liquids, solids and gases, dissociation, fusion, ebullition, conduction, radiation, electrical resistance, acoustics, vicosity, color, specific heat, thermo-electrics, etc. The principles upon which each of these phenomena operate will be considered with the individual instruments.

Probably next to his watch man consults his thermometer as much as anything of his many and varied inventions and it rules him just as strongly as his timepiece does. It compels him to put more coal on the fire in the winter time when he finds the indicating fluid sinking too low, and in the summer it forces him into thinner and lighter raiment. Did you ever pass a thermometer without reading it? Neither did anyone else.

THE FIRST THERMOMETER

The credit for the first thermometer goes to Galileo of Padua who, in 1592, invented an instrument described as "a glass containing air and water to indicate changes and differences in temperature." It consisted of a glass tube about sixteen inches in length with a hollow bulb fitted in the end. The whole was heated until the air inside became rarified, when the open end was placed in water, the tube being kept upright. As the air in the tube and the bulb at the upper end cooled and con-

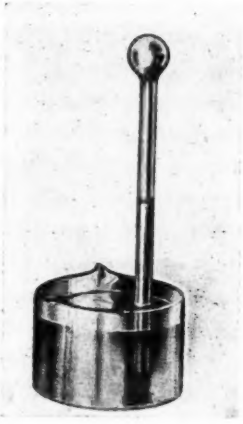


Fig. 1.

Sanctorius' Thermometer of about 1620—representative of Galileo's first thermometer.

tracted, the fluid in the tube rose to a certain point and any subsequent changes caused the level of the liquid in the tube to either be elevated or depressed, while an arbitrary scale gave a rough indication of the temperature changes. Drebbel of Holland is frequently mentioned in connection with the early thermometers, but the credit for the first is generally given to Galileo.

Sanctorius, a professor and physician at Padua was the first to use this principle as a heat measure or fever thermometer in 1611. He had his patients hold the top of the tube or bulb and the raising or lowering of the liquid in the tube indicated the patient's condition.

About 1630 a French physician M. Jean Rey, made a similar thermometer but used alcohol and kept his instrument in an upright position, noting the rise and fall due to the expansion of the liquid itself and not to the enclosed air in the tube. It was shortly after this that the Grand Duke of Tuscany improved upon Galileo's thermometer and used alcohol in a sealed tube, while some of Galileo's students made a scale by melting beads of glass to their thermometer tubes to indicate points of temperature.

Later on a need was seen for a definite scale with fixed points and Newton, in 1701, prepared such a scale using the melting point of ice, the temperature of the human body, the boiling point of water, and the melting point of tin as points of reference.

THE FAHRENHEIT THERMOMETER

In 1714, several years after Newton's work, considerable advances were made by Fahrenheit of Dantzig, Holland, and it is the Fahrenheit scale that is mostly used today in temperature-indicating instruments. Many theories, all really uncertain, have been given as to the method by which he arrived at the several points of his scale, the one generally accepted as the most probable, being as follows: According to this theory Fahrenheit adopted, as the zero of his thermometer, the temperature which had been observed at Dantzig, in 1709, which he found he could always reproduce, by using a mixture of ice and salt. At that temperature (which he believed to be an absolute zero of cold) he computed that his instrument contained 11,124 equal parts of mercury, which, when plunged into melting snow, were increased to 11,156 parts. Hence the space included between these two points (viz., 11,156 —11,124 = 32) was divided into 32 equal parts, and

32 degrees indicated, therefore, the freezing point of water. When his thermometer was plunged into boiling water, Fahrenheit estimated that the mercury was expanded to 11,336 parts or 212 parts above his zero, and therefore 212 degrees (11,336 —11,124 = 212) was marked as the boiling point of that fluid. In practice, Fahrenheit determined the boiling point of water, and the melting point of ice, and then graduated the tube by equal divisions to his zero. To Fahrenheit belongs the merit of having introduced the use of mercury in thermometers, which had previously been made only with alcohol, water, or air. He also introduced cylindrical bulbs to increase sensitivity.

THE CENTIGRADE THERMOMETER

The second most popular of our present-day scales known as the Centigrade, from centum meaning one hundred and graduum meaning graduations, was devised in 1742 by Celsius, a professor of astronomy at the University of Upsala. He divided the distance between the boiling point and the freezing point of water into 100. However, his scale was inverted, the freezing point being taken as 100 and the boiling point as zero. Shortly afterwards (1743) Christin of Lyons, France, reversed these points producing the modern Centigrade scale of today.

The third thermometric scale in use today, particularly in Europe, is one made by Reaumur a French physicist in 1731. He studied the use of alcohol in a thermometer and found that a certain mixture of alcohol and water expanded from 1000 parts to 1080 parts between the freezing and the boiling points of water. Taking the freezing point of water as zero and the boiling point as 80 he divided his scale into 80 equal parts.

Thus we see the comparison of the three systems, all based on the boiling and freezing points of water, 212 degrees F., 100 degrees C. and 80 degrees R. representing the boiling points and 32 degrees F., 0 degrees C. and 0 degrees R. representing the freezing points, the zero on the F. scale being 32 degrees below the freezing point.

Several methods of obtaining the values of one scale in terms of the next are available though possibly somewhat confusing unless one pictures the three systems side by side. To eliminate confusion, let us consider conversion of C. and F. degrees only, as R. degrees are seldom used in comparison with the extensive use of the others. By following the drawings we see that $°F = (°C \times 1.8) + 32$, while

°C = (°F — 32) ÷ 1.8 or by the same method but using fractions instead of decimals °F = (°C x $\frac{9}{5}$) + 32 and °C = (°F — 32) x $\frac{5}{9}$. Another very simple scale which eliminates the confusing 32 is as as follows:

°F = (°C + 40) x $\frac{9}{5}$ — 40, while °C = (°F + 40) x $\frac{5}{9}$ — 40.

Mercury, as the activating substance for a thermometer, has several advantages over other substances. In the first place it has a wide range, or fortunately a range which meets most general demands. It freezes at —39 degrees F. and does not boil until it reaches about 675 degrees F. under ordinary pressure. By increasing the pressure mercury thermometers are available today which will record temperatures several hundred degrees above this point. Secondly, the fact that mercury has a uniform and regular rate of expansion is a valuable point in its favor, as many liquids may expand slowly at lower temperatures and rapidly at higher temperatures, which makes them very unsatisfactory for this purpose. In the third place, mercury does not cling to glass as other liquids do, and finally it may be easily obtained in a purified state. Being opaque it can readily be observed in fine capillaries.

MAKING A THERMOMETER

The actual making of a mercurial thermometer is a very interesting and a most exacting process if the resulting thermometer is to give accurate and consistent readings, and after following Mr. Thermometer through his make up we will no longer wonder why it is that "good" thermometers cannot be had at the "five and dime," but must be paid for with good cash.

In the first place, the glass used must meet very exacting demands. It must rapidly return to its normal state after exposure, for glass like most everything else, expands when heated and contracts when cooled. It must remain clear when heated and must not become clouded. Many poorer quality glasses cloud up considerably. It must not soften at the temperatures with which it is to be used, nor should it be distorted, a feature we see in most of the common window glass in our homes. It must give clear cut markings so that it can be properly graduated.

When such a glass as is required for the particular type of thermometer to be made, is found, the next step is to prepare the long capillary tube. A quantity of melted glass is taken up on a hollow

pipe and a bubble is formed in the glass by blowing through the pipe. Then by manipulating the pipe the operator rolls the glass out into a cylinder, the bubble now becoming elongated with the mass of glass. The mass is then somewhat flattened, enamel glass is placed on the part of the cylinder behind the inner core or bore as it is called and the entire mass is again dipped in hot glass to cover and

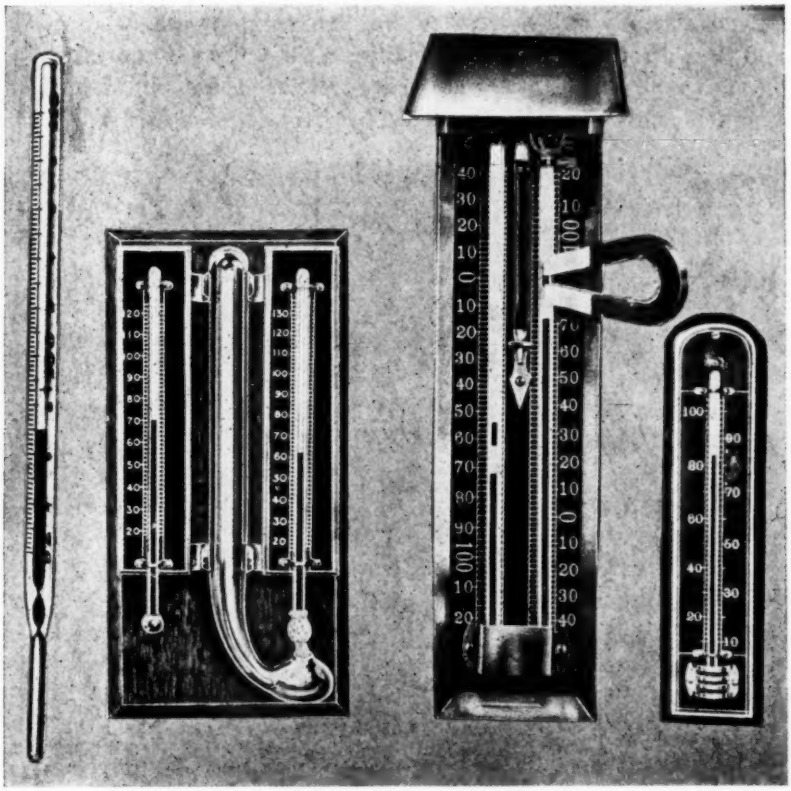


Fig. 2.

a. Clinical thermometer; b. wet and dry bulb thermometer; c. maximum and minimum temperature thermometer; d. household thermometer.

protect the enamel. If the tube is to be V-shaped, or lens shaped, as most clinical thermometers are, to facilitate easy reading, it is forced into a mould at this time.

One end of the cylindrical tube is then fastened down while the other end is gripped firmly and drawn upwards for about 150 feet

with the result that the cylinder has been stretched out for that distance and now is in the form of a long perfect tube with an extremely fine hole in the center. This tube is then cut into convenient working lengths which are carefully sorted out according to the size and uniformity of the bore, some of which are actually finer than a human hair. This grading is done very carefully with the aid of a microscope.

These tubes are now cut to smaller lengths. One end is sealed and then after softening by a blowpipe, air is blown into the opposite end until a bubble or bulb has been formed, the size of the bulb being carefully regulated by the skilled operator so that it will func-

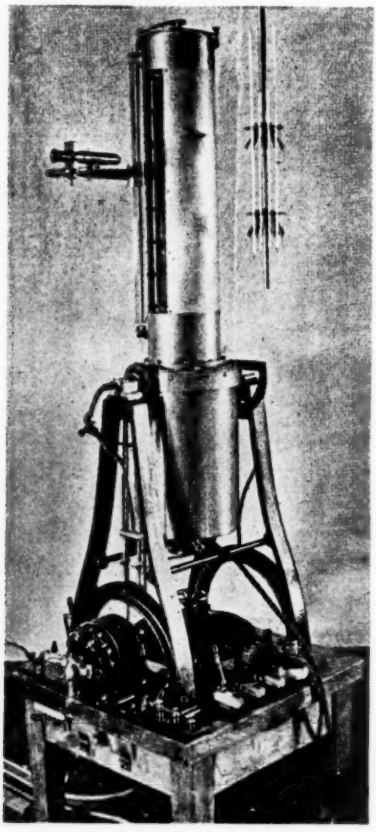


Fig. 3.

Apparatus for Testing and Calibrating Precise Thermometers.

tion properly with the tube in question. It is at this point that the sensitivity of the thermometer is determined, as improper regulating will give a bulb which will be all out of proportion to the bore of the tube and either give too little or too great a rise in the mercury column for accurate readings.

After the bulb has been formed to the correct size and while it is still hot, the open end of the tube is placed in pure quicksilver and upon cooling the quicksilver is drawn up into the tube. The bulb is then heated and again the tube is dipped into the mercury, repeating the operation until the bulb and tube are completely filled. The tube is then "roasted" to drive out all moisture and finally the open end is drawn out to a fine capillary, the bulb is again heated until the mercury rises in the tube and expels all the air. Finally with a blow pipe, the capillary is shut off and upon cooling the mercury again flows back to the bulb.

The next step is the graduation of the tubing. This is accomplished by placing it in baths of known temperature usually 2 degrees, 32 degrees, 62 degrees and 92 degrees F. and marking the reading on the tube in each case. If these four points are equidistant, then it is a simple matter to subdivide each section into thirty equal spaces. The tube is placed upon a brass plate and the marks which denote 2 degrees, 32 degrees, 62 degrees and 92 degrees are reproduced at exactly the same positions as they appear on the tube, after which a dividing or marking machine does the rest. Then comes the ageing for two or three years, for unless this is done, there may be considerable variation in the reaction of the glass due to shrinkage, for instance the temperature may be raised from 30 degrees to 80 degrees but when the thermometer is brought back to its original surroundings, it might only record 32 degrees instead of 30. After ageing, the thermometer is finally ready for the market.

Is it any wonder therefore that these little instruments, that is, good instruments, are expensive? Of course, there are cheap ones avaliable for those who desire them, thermometers made of poor glass, carelessly graduated, carelessly attached to the scale or with possibly a painted scale, bulbs which do not fit or match up with the bore of the tube which may be uneven in itself, thermometers not aged, poor quality quicksilver, etc. These are the thermometers which you look over in a case and finding that no two agree in reading finally give up in despair. Of course they would probably tell

you whether it was the dead of winter or the middle of summer, but to most of us, thermometers are more useful than that.

THE CLINICAL THERMOMETER

The clinical thermometer as first originated, was about ten inches long, the short stem variety of today being originated by Clifford Allbutt in 1867. This thermometer is a short range thermometer, 95 degrees to 110 degrees F. and is a maximum type, that is, the mercury column stays at the maximum reading until it is shaken down. This provides an opportunity to obtain an accurate reading and it is accomplished by having a restriction in the bore of the tube, or a small glass hair or splint, called a "choke bore" prevents the mercury from receding. Frequently this fine glass hair is broken by shaking down a thermometer, which should therefore be handled carefully and not jarred too severely, the proper method being to grasp the upper end of the thermometer and to describe an arc merely with a twist of the wrist. The bore and bulb of a clinical thermometer must both be very fine to give delicate readings, and with such a fine bore it would be almost impossible to read the position of the mercury without the "lens" front which is usually found and which magnifies the capillary very nicely. These thermometers are available usually as one-half, one- and two-minute instruments, which simply means that one gives quicker results than the other.

LOW-TEMPERATURE THERMOMETERS

Thermometers for temperature readings below the freezing point of mercury usually employ alcohol which does not freeze until it reaches 176 degrees below zero which is well beyond the normal call of a thermometer. To make its column readily noticeable it is colored with a dye, usually bright red. This has frequently led to the assumption that this material was red mercury and more than one call has been made for such a substance.

Beyond the range of alcohol are several liquids which have still lower freezing points, such as pentane, which will record as low as 200 or 300 below zero, or below the temperature of liquid air.

Only recently gallium, another chemical, has been used in place of mercury in a thermometer for high temperature ranges, as it will record up to 1800 degrees. Of course ordinary glass at this tempeature would be unsatisfactory as it would melt, so a fused quartz tube is used to replace it.

GENERAL THERMOMETERS

However, before we leave the mercury type of thermometer, let us mention several other applications of it to everyday needs. There is, of course, the bath thermometer, often encased in a wooden block and frequently with a large hollow tube so it will float on the surface of the water. This is graduated in terms of suitable bath temperatures, such as tepid, warm, hot, etc., as well as indicating actual degrees. Baby's baths must be carefully controlled and physicians today recommend baths of definite temperatures for different ailments, a certain one being for the treatment of a cold, while another is to sooth and allay the nerves, or possibly to rest the body or relax the muscles. In other words there are many more reasons for a bath today than just the fact that it is Saturday.

The housewife also wants a thermometer for her oven, for recipes today are based on definite temperatures and with this control, burnt offerings are naturally not so frequent. She also finds that a candy thermometer graduated in terms of that art is quite an aid, replacing somewhat the old "hairing" and "hard ball in water" technique. A similar one is available for jelly-making, so there is no longer any reason for the grape mixture not to jell.

The chicken incubator also has its own specially prepared thermometer set at 103 degrees, and we all know what temperature control means there, where a variation of only a degree or two means no chicken or a cooked one.

Mercury thermometers are also prepared for measuring deep water temperatures. In order to overcome the difficulty of having the thermometer reading changed while it is being drawn up, the instrument is ingeniously made so that it is lowered upside down and at the desired temperature, a trip releases it so that mercury will act, and once it does, another arrangement prevents it from dropping back or raising higher up in the tube.

Another interesting thermometer is the maximum and minimum type. This is made in the general form of a U with a bulb on each end. The scale on one arm of the U covers the lower range of temperature, while the one on the other arm covers the upper range. In moving back and forth in the tube, a mercury column forces a fine glass capsule containing a fine piece of steel ahead of it, which remains stuck in the tube when the mercury recedes, thus indicating the maximum or minimum points reached by the

mercury column. To reset the instrument, a small magnet again draws the capsule down to the mercury column.

HYGROMETER OR HUMIDITY METER

A double thermometer in which one bulb is kept moist is used to determine humidity or the amount water vapor in the air. From our previous discussion of this subject we know that the air will take up moisture to the point of saturation and the more moisture in the air the less it can take up. We also know that evaporation produces a cooling effect, and it is upon these principles that this instrument, the hygrometer, is based. The two thermometers are set up practically side by side, one being the ordinary dry bulb type while the bulb of the other is covered with a fine silk bag or wick which dips down into a cup of water. As the moisture from the bag evaporates, it produces a cooling effect on the liquid in the thermometer bulb, the faster the evaporation, the greater the cooling effect, the speed of evaporation depending on the present moisture content of the air. By taking the reading of the two bulbs and noting the difference between them, one can refer to a prepared chart which at once tells the relative percentage of moisture present in the room.

Another instrument based on this principle, is the hydrodeik. In this case a needle swings across an arc and readings are taken where certain connecting lines between wet and dry bulb temperatures coincide.

As the instruments described above do not give true readings because they may be operating in quiet air and the actual air surrounding the instrument may be nearly saturated, sling hygrometers have been devised. In these, the two thermometers are attached to a handle whereby they may be whirled about, thus obtaining the maximum cooling effect from the wet bulb. These instruments are usually spoken of as whirling psychrometers.

Instruments for recording moisture content have also been made using a hair as the controlling factor. This is based on the fact that a hair stretches when it is moistened and tightens up when it is dry, the amount of extension being calculated as 3/128 of its length in saturated air. This reaction is made to record on a scale, of course.

If you want to experiment with a unique thermometer next summer, try the vocal thermometer as indicated by the crickets. Experiments have been made to show that the chirping of a cricket is

definitely linked up with the prevailing temperature. The temperature in degrees F. equals the number of chirps made in fifteen seconds plus 37 and there is about 1 degree rise for every four chirps per minute.

THERMOMETERS BASED ON OTHER PRINCIPLES Many types of thermometers have been made in which the expansion and contraction of a gas, other than mercury, has been used. In these, the gas, in an enclosed bulb or case, comes in contact with the source of heat and expands, either pressing directly against an indicating needle or working against a mercury column or manometer which then operates the needle.

Air thermometers were in early use as scientific instruments. Princep in 1827 was the first to put this idea into actual practice. He used a bulb of gold connected to a reservoir of olive oil which exuded as the bulb expanded, the temperature of the bulb being determined by weighing the displaced oil. Davy later used a similar device in which he replaced the oil with mercury.

Pouillet with a platinum bulb was able to reach the highest temperatures, and his work laid the basis for pyrometry of today. He took definite steps in radiation pyrometry by determining the temperatures at which solids glow, then calorimetric pyrometry by determining the specific heat of platinum and finally thermo-electric-pyrometry by calibrating a thermocouple of iron and platinum.

Displacement of one gas by a second is another important method of operation. The determination of vapor densities at higher and higher temperatures are thus made and from this all high temperature thermal measurements depend.

As far back as 1731, there were devices available based on the expansion of solids themselves, such as the single-bar device where one end of a bar is held stationary and its lengthening upon heating is read off on a scale in terms of degrees of temperature. This was followed by instruments which were based on the differential expansion of two solids, such as iron and brass for instance. These were firmly joined together and shaped into a coil, one end of which was held stationary while the other was allowed to open up or contract as the case might be, due to variations in temperature, a needle on the free end indicating the temperature.

Fusion points of metals have been of great value in determining temperatures and the melting points of some pure metals are today used as points of standard reference. Ingots of alloys, prepared to melt at various temperatures are placed in a furnace and the temperature is then indicated by the melting down of certain cones, and noting that others which have higher melting points have not been affected. Seger's cones which are used in porcelain manufacture depend on the softening of cones of clay. Holdcroft's thermoscopes, also of this type, are small bars supported at their ends and in a horizontal position. When the critical temperature is reached, the bar sags in the middle.

Specific heat has also been mentioned as a basis of action and in this we find temperature is measured calorimetrically. Iron and copper, for instance, are exposed to heat and then plunged into water under definitely controlled conditions whereby the increase in temperature of the water may be measured. Or the hot air of a blast is cooled with a known quantity of cold air and the resulting temperature is measured.

Boiling points of liquids and solids have also been used to indicate temperatures and our question of conduction is another means of approach. A bar of iron for instance is placed in a furnace and the temperature at various parts of the bar, cool enough for measurement with a mercury thermometer are made, or water is measured before and after leaving a furnace.

Acoustics or the question of wave lengths has also been the basis of temperature measurement. This is based on the velocity of sound in dry air at different temperatures. We have all heard the screech of a swinging sign on a cold winter night or the shrill squeak of the wheels of the coal truck, sounds which we do not hear during the summer months. Compare these with known notes and record them in terms of temperature and we have a thermometer.

THERMO-ELECTRIC INSTRUMENTS

Thermoelectric instruments, or thermocouple pyrometers as they are called, offer a very interesting means of determining temperatures. These are based on the principle that an electric current is set in motion when two dissimilar metals are heated at their junction. These instruments cover temperature ranges from about 100 degrees upwards.

They measure the temperature at this hot junction point only, consequently giving quite accurate readings and because this point is so fine, temperatures can be determined where the dimensions of the hot space scarcely exceeds a physical point. The thermal indications are instantaneous. The electric current which is set up through the fine wires of this instrument is recorded by a sensitive galvanometer which operates a needle against a temperature chart.

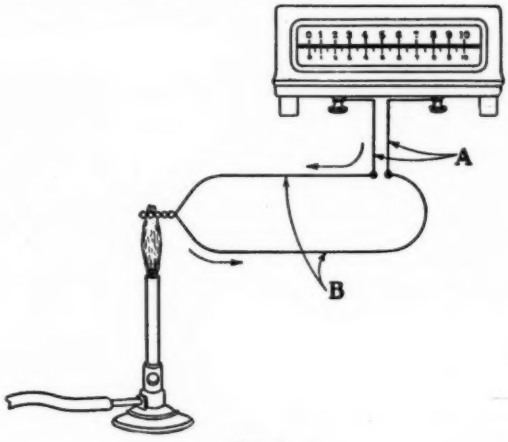


Fig. 4.

Principle of Thermo-electric Meters or Pyrometers.

HEAT OF STARS

The temperature of the stars are measured by just such instruments as this. A 100-inch telescope is used to concentrate the greatest possible amount of starlight, but even this would be useless were it not for the incredible sensitiveness of the receiving apparatus. The stars rays pass through a transparent window into an exhausted receiver and fall on a tiny thermocouple. The wires of the couple are hardly more than 1/1000 of an inch in diameter and the entire couple weighs less than 1/600 of a grain, the part which is heated at any one time by the star's rays weighing only 1/2000 of a grain. The heat from the most active star, when concentrated on this tiny speck, raises its temperature less than 1/60 degrees, setting up a current of 1/7,000,000 of an ampere, but the galvanometer is so sensitive that the recording spot of light swings through an arc eighteen inches long. 1/100,000 of a degree has been measured and any star which can be seen by the naked eye can be estimated.

This instrument could detect the heat of a candle 100 miles away if there were no loss due to absorption by the intervening atmosphere. Focused on a group of candles it could actually count the number in the group.

RESISTANCE THERMOMETERS

Resistance thermometers are made to cover ranges approximately from 300 below zero to 1000 degrees above. These are based on the fact that most

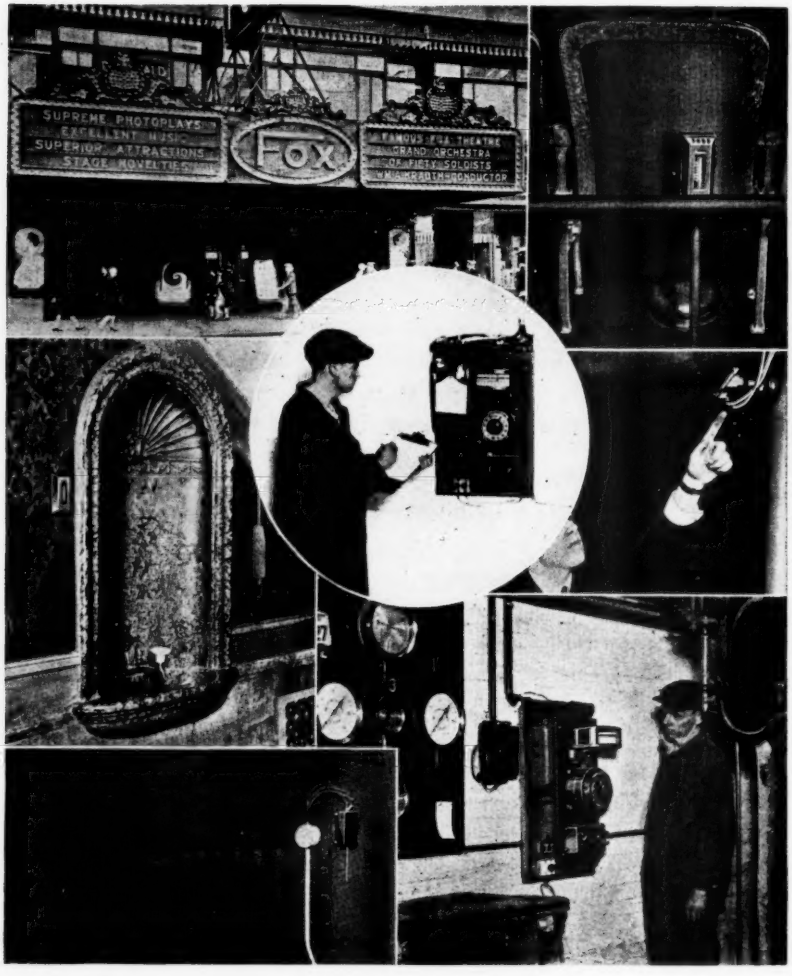


Fig. 5.

Application of Distant Recording Thermometers Showing Various Locations of Resistance Bulbs and Central Recording Station.

electric conductors change their electrical resistance with variations in temperature, these changes then being measured in electrical units and automatically converted into degrees F. or C. A wheatstone bridge is used to balance up the instrument to surrounding conditions and a bulb containing pure nickel or platinum wire is used at the source of heat. As the temperature rises the resistance of the wire in the bulb increases and this resistance is then measured by again balancing the bridge.

RADIATION THERMOMETERS

Radiation is also used as a means of measuring temperatures. Optical pyrometers are available in which the temperature is determined by matching the luminosity of a hot body with that of a calibrated source or by

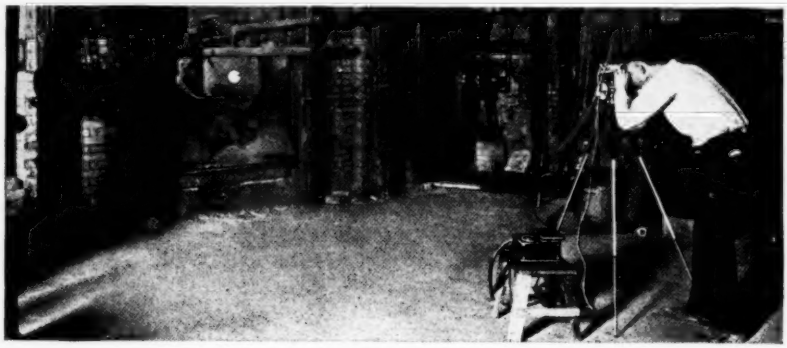


Fig. 6.

Radiation Pyrometer in Use.

utilizing the visible radiation emitted from a hot body. An instrument of this type is of little use therefore on articles not heated to the point of incandescence and can be used only when the operator can directly observe the heated body. Its use begins with temperatures of about 1400 degrees. Instruments of this type are used in steel mills where the heat radiated from a furnace, for instance, is caught by a concave mirror, at the focus of which is a thermometer.

HEAT OF THE SUN

The bolometer which is used to measure the heat of the sun is based upon radiation as is also the pyrheliometer, an instrument used for the same purpose, in which the light ray falls on a black disc through a small aperture

in a tube, the disc being heated and its temperature subsequently being measured by a thermometer.

In the bolometer, the sunbeam falls on a spectroscope which breaks it up into its component parts. We can only see certain waves in such a spectrum, but others such as the ultraviolet, etc., are also present and it is necessary to absorb the heat of these on lamp black and then measure that heat by the sensitive bolometer. This consists of two very small blackened hair-like ribbons of platinum linked up to two coils of wire to again form a wheatstone bridge which is connected to a battery and a highly sensitive galvanometer, capable of detecting a change of temperature in one of the platinum ribbons as low as 1/1,000,000 of a degree. As the spectrum is moved over this instrument, its heat effect is recorded on the galvanometer index and a record is kept on a moving photographic plate. Such an outfit, simple as it sounds, requires some twenty pieces of apparatus, weighing several tons and costing in the thousands.

There are many more of these most interesting and fascinating instruments available but time will not permit us to consider them all. We have barely pricked the surface of the subject of heat, its uses, its measurement, its place in our daily lives and very existence, but I believe you will agree with me that it is a most fascinating subject and if you have enjoyed hearing a little about it I shall feel amply repaid for the time I have spent in preparing it for you.

REMINISCENCES OF AN EXPERT

By Henry Leffmann, A. M., M. D.

MY FIRST INTRODUCTION to the methods of expert testimony was in the early 70's. As assistant to Drs. Charles M. Cresson and B. Howard Rand, I took part in experiments in making paper from wood, relating to a suit over the validity of patents thereon. Like most advances in applied science, the problem had been attacked by many persons, but it seemed that the real advance consisted in boiling the wood (in suitable fragments) in a solution of sodium hydroxide at about 300° F., in a closed boiler. Many experiments were made. During one of these in which a piece of gas-pipe was used as a pressure tube, an explosion occurred and had a fragment been directed toward me, "the subsequent proceedings" would have interested me no more.

Dr. Henry Leffmann

I was not called as a witness in this case, but I read considerable of the printed testimony. Somewhat later I was a witness in a suit concerning the condition of a shipment of bleaching powder. It had been long on the voyage and the importer wished to avoid taking it, alleging that it had suffered deterioration. There was some, but not much. The case was tried in the civil court, the lawyers being distinguished members of the Bar. During the trial one of them had occasion to read from a law book and had mislaid his spectacles. While looking for them, his opponent said, "Perhaps, Mr. Miller, my glasses will help you." "Oh, Mr. Dickson, I could not see the law correctly through your spectacles."

In the middle 70's a Democratic Coroner was elected in Philadelphia and Dr. Frank Maury, a brilliant young surgeon, assistant to Professor S. D. Gross, was appointed Coroner's physician. He at once promised me that I should have the toxicologic material from the office. Very soon after, two cases of suicide by arsenic were "posted," and I had at the beginning of my career an opportunity to see arsenic stomachs of the two types—one in which high inflammation with extravasation of blood occurs, and the other in which the stomach is not inflamed. In the latter case, that of a man who had taken about a teaspoonful of a powder then commonly sold under the name

"Rough on Rats," death had occurred under symptoms of coma, without evidence of stomach inflammation. The powder was sold with slight admixture of lampblack to prevent it being mistaken for flour or sugar. I have a small vial full of the material taken from the stomach.

In the late 70's a very interesting case of criminal poisoning occurred that attracted much attention. It is not necessary to give names. G was a man about thirty, who was called "doctor" although he had no degree. In those days any one could practice medicine, put up prescriptions, dispense a narcotic, without having any professional training. G's father had been practicing as a homeopath and his son continued in a limited way using the triturations that were in the home. He made the acquaintance of a woman several years his senior, whose mother had some real estate. He induced the daughter to marry him and then induced the mother to make a will leaving all the property to the wife. He then (as was proved later) killed the mother with arsenic, probated the will and got his wife to make a will leaving all the property to him. He then killed her with arsenic. The physician attending the wife could not state the cause of the death and the Coroner ordered an autopsy. The stomach was sent to me. It was highly inflamed and several grains of arsenous oxid in crystal form were washed off of it. All confirmatory tests were made. The body of the mother (she had been buried under a certificate of death from Bright's disease) was exhumed and arsenic was also found in the stomach and in other organs. The man was convicted, obtained through the State Supreme Court a new trial, was again convicted and finally hanged. At the second trial an attempt was made to show that the arsenic in the wife's body was due to her using arsenical triturations (homeopathic) which she had found in the home, but I testified that the arsenic in the stomach was in distinct crystals and had not suffered trituration. Long afterwards I learned that from the beginning of the case, the defense attorney had in his possession the bottle of arsenous oxide from which the prisoner had taken the portions given to the women. Subsequently the bottle with the contents was given to me. It was as I had testified, ordinary, commercial white arsenic in broken crystals.

Leaving the gruesome for the present, a brilliant remark of Judge J. I. Clark Hare may be recorded. While I was waiting in court for a case in which I was engaged, I listened to the trial of a damage suit, brought by a woman who had been injured by stepping

on a board placed temporarily over a coal-hole in Chestnut Street near Seventh. Her attorney (a well-known, but not admired member of the Bar) had a board brought into court, similar to that which the testimony showed had been used as the cover. The attorney prefaced his offer of the evidence, by saying, "Your Honor, there is a case on record in which a barn-door was brought into court. I have brought a board of the type used in this affair to show the jury that it was not a sufficient covering." "Now," said the judge, "Mr. ———, if you could bring the hole into court we would have the case fully before the jury."

A very sad case was that of a woman hanged for the murder of her three (small) children for the sake of the insurance, the whole being but a few hundred dollars. She used arsenic. No difficulty was found in determining the cause of death, portions of the arsenic having been obtained from the stomach in each case and the distribution of the poisons in the bodies shown. A strong effort was made by a graduate of the Women's Medical College to secure a remission of the penalty on the ground of insanity, but it failed. The crime seemed to have been deliberate.

In one of the cities of the anthracite region of Pennsylvania, a number of sudden deaths occurred, the victims being insured in the interest of a certain man. Suspicion being aroused I was asked to make an examination and found clear evidence of death by arsenic. The District Attorney of the county decided to take up two other bodies, the mother and father of the man. The latter had been buried several years, the other not quite two. On opening the coffin of the woman, the body was found in a good state of preservation, and the stomach showed clear evidence of irritant poisoning, which was proved to be arsenic. Certain parts were taken and the coffin was closed. On opening the other coffin nothing was found but the skeleton and a few fragments of shroud. Portions of the skull and the sacrum were taken, but tests failed to show any arsenic. Owing to the fact that the District Attorney could not trace the purchase of arsenic to the prisoner, he decided not to try him at that time but await further developments which, however, never occurred in such form as to justify re-arrest. However, shortly after the exhumation, a woman went to the priest of the church to which the cemetery belonged, complaining that her husband's grave had been disturbed. Being told that the grave was not that of her husband but of another man, she stated that on the occasion of the burial of the woman a mistake was made and the body was put in her husband's grave. *So I had the wrong man!*

The Holmes case requires a distinctive heading. It was one of the most complicated and desperate series of crimes that have ever been unraveled in the criminal records of Philadelphia. The trite remark that it would take a book to give all the details is inopportune here for a book was written about it. Mr. Geyer, who was the special detective to District Attorney George S. Graham, solved the problems of the case, not by Sherlock Holmes methods, but by persistent following up of clues, many very slight in themselves, but taken as a whole pointing unerringly to the guilt of the prisoner. In addition to the crimes of which he was convicted in Philadelphia, he was wanted in several other places, but Mr. Geyer's remark to me when the trial was about to begin: "When Mr. Graham is done with him, no one else will want him" was true. The crime for which Holmes was executed was the murder of a man named Peitzel. He induced this man to go into a scheme for defrauding an insurance company. He was to get insured and Holmes was to substitute a body which was to be identified as Peitzel and the insurance money divided between the two. H. said that he had been a medical student and knew how to get bodies from the colleges. Mrs. Peitzel was a party to the scheme, presumably forced into it. The couple had several children and were quite poor. What really happened was that Holmes killed Peitzel. Mrs. Peitzel, who was living at a distance from Philadelphia, sent her oldest daughter, a girl about twelve, with instructions that she should say that the body was that of her father no matter what appearance it had. As a matter of fact the girl saw that it was her father's body, but Holmes managed to prevent her getting back to her mother, so the latter remained in ignorance of what had occurred until facts came out in the investigation. Holmes was arrested and subjected to severe examination by the detectives (the third degree), and made the fatal mistake of connecting himself with the body, that is, told how he had left the house which they had rented in Callowhill Street near Thirteenth, and returning an hour or so later had found Peitzel, lying on the floor, with a gallon bottle two-thirds full of chloroform resting on a chair, and closed by a cork carrying a quill to which was attached a rubber tube leading under a towel placed over Peitzel's mouth. In other words, he claimed that Peitzel had committed suicide. The story was entirely lacking in credibility. The arrangement described was impossible to operate and on my examination its worthlessness was shown. The jury had no difficulty in finding a verdict of murder in the first degree. All

subsequent efforts to free the prisoner failed and he was hanged. The trial attracted widespread interest. On the afternoon when I was on the witness stand the representatives of about two score newspapers were present taking notes.

I note a very remarkable case, in the recital of which I suppress names, as some of the persons concerned may be still living, though I think it unlikely. A. was supposed to be a safe-robber. He occupied rooms in a house in a second-rate residence locality in the north-central part of the city. The front room, lower-floor, was occupied as a barber-shop in which an apprentice about sixteen years old worked. A. left the city for a short time, whether on vacation or vocation I cannot say ('T is my vocation, Hal; 't is no sin for man to labor in his vocation"). When he returned, his wife was missing. What steps were taken to seek her I do not know. The affair seemed to have attracted little attention. About a dozen years after this, a carpenter was employed to make some repairs in the house. Curiously, I had known him for many years. On tearing up the kitchen floor, the skeleton of an adult, entirely denuded of flesh and with a ragged silk handkerchief tied in two close knots around the spinal column was found. The metal portions of a cheap pocketbook and a few coins were lying alongside the skeleton. The husband and some women friends positively identified the remains as the missing wife. The apprentice, who was then about thirty years of age and had a wife and children was arrested and subjected to examination. He told a story of which the following is a brief outline. He said the woman came in drunk and died in consequence of vomiting, causing in her helpless condition obstruction of the windpipe. He was afraid that the husband would charge him with the murder, and he buried the body under the kitchen floor. It must be borne in mind that he had lived for some years in the house after the event. Presumably, rats had eaten the soft parts of the body and possibly carried away pieces of the clothing. The case was tried in due course and the man was convicted and sentenced to be hanged. He was, however, allowed to remain in prison for a number of years and finally pardoned.

I was called for the defense, merely to testify that suffocation by vomiting during deep drunkenness could occur, but the view taken by the defense while not impossible could not be established sufficiently to influence the jury.

The case has a special interest for me on account of the manner of the murder, as claimed by the prosecution, namely, that the woman

was strangled by tying the silk handkerchief closely in two hard knots. She was in the habit of wearing the handkerchief loosely tied around her neck. In Dickens' incomplete novel, "The Mystery of Edwin Drood," there are two points which have been subjects of much discussion among Dickensians—the disappearance of Drood and the identity of Datchery. The latter does not concern us here, but I am one of the Dickensians who is entirely of the opinion that John Jasper murdered Drood by means of a strong black silk scarf that he (Jasper) usually wore. In the case just described the body was identified, as I have said, by the silk handkerchief which was about the only definite relic of her attire. In the novel, however, Dickens evidently intended that all portions of the body and clothing should be destroyed by quicklime before the discovery was made and the identification to be made by a ring set with gems. Dickens' theory that lime would cause such complete destruction was erroneous, but novelists create an unreal world and we must not hope for expert knowledge.

High crimes are, however, not by any means the sole occupation of courts. In the extremely complex community life of today, a vast number of disciplinary regulations are necessary. "Because sentence against an evil work is not executed speedily, therefore the hearts of the sons of men are set in them to do evil." My expert experiences have included tariff suits, patent and trademark litigation, a few cases involving purely medical testimony, and last but not least, a large amount of work under the Dairy and Food Commissioner of Pennsylvania in the enforcement of the food laws. In the latter relation I was the pioneer, my work having begun in the middle 80's during the term of Governor Robert E. Pattison.

The beginnings of Food Control in Pennsylvania were concerned with the sale of butter-substitutes as real butter. There were, indeed, some general laws but they could only be satisfactorily applied in flagrant cases. The crusade against butter-substitutes was begun by the farmers, through the official organization known as the State Board of Agriculture, consisting of a delegate from each county that had a yearly county fair, together with some persons appointed by the Governor, known as "members at large," and some experts. I was for a number of years the "Microscopist and Hygienist," but my duties were very light. No member received a salary, but expenses of attending the meetings were paid and any outlay for actual work. Efforts were made by the members to have a special officer appointed but there were legal difficulties, and finally the plan was adopted of

appointing a member of the Board as Dairy and Food Commissioner. Governor Pattison appointed Eastburn Reeder of New Hope, Bucks County. Under his authority I began to test the butters offered in the markets of Philadelphia, and found samples which were evidently adulterated with fats not derived from milk. After much discussion and pressure the legislature passed a law prohibiting the sale as butter or as a butter-substitute any article "not made wholly from unadulterated milk or the cream thereof," allowing no sale under marking or advice to buyer. The act was absolutely prohibitive, and a sale whether the seller knew the nature of the article or not was punishable. Later, the law was modified so as to permit sale with plain labeling, but a very large amount of substitution still occurred. It was in the course of a very extensive series of analyses of samples collected by agents of the Dairy and Food Commissioner, that in association with Dr. William Beam, the glycerol-soda method was developed which had a meteoric career that ended in its adoption by several nations including this as an official process. Gradually the field of control was widened, until all articles of food were covered and of late years drugs have been included in the supervision. When general food control was begun in Pennsylvania, a great deal of adulteration and substitution was prevalent. In such articles as jams and jellies and in ground spices frauds were abundant and flagrant. Preservatives were largely used, salicylic acid being most common, but some of the larger manufacturers were using sodium benzoate. Dr. Beam and I made a great many experiments in this field, and found that sodium benzoate was much less objectionable, especially in relation to starch digestion, than salicylic acid. Acting on this information, the Dairy and Food Commissioner permitted the limited use of the former in certain perishable products, such as jams and jellies. Chemical analyses of the curious mixtures that were then openly sold was impossible, but statements of manufacturers afforded interesting information. Thus, a certain brand of strawberry jam sold for a small sum in a wooden bucket about the size of the tins used by children for playing in sand, was made up of: jelly from apple corings and peelings, glucose, grass-seed (to imitate the achenia of the strawberry) dilute sulphuric acid (for tartness) anilin red and sodium benzoate. There was not any strawberry substance in it! Adulteration of milk by skimming and watering and by addition of preservatives, especially formaldehyde was common, but the most serious condition was the lack of general sanitary control, such as keeping cattle in good health, collecting and

transporting under rigid cleanliness. Much effort was needed to secure improvement in these respects, but at the present time conditions seem to be fairly satisfactory.

A very sad series of incidents in food adulteration occurred in the middle 80's before any systematic control had been established. Cases of obscure and sometimes fatal diseases developed in the family of a baker in Kensington. His wife and several children died. Probably on account of the feeling of the neighbors he moved to another section of the northeast where later he married again. Further instances of the disease appeared and the baker's second wife became ill. This case and some others came into the care of Dr. David D. Stewart, engaged in regular practice and very observant in his work. On examining the wife he found evidence of chronic lead poisoning. He questioned the baker closely and finally was shown a pitcher containing a yellow powder which the baker confessed he had been using as a substitute for eggs in a product known as "breakfast buns," which had a large sale. Thorough inquiry was at once set on foot. Another baker and a maker of noodles were found to be using this substance, which was chrome yellow, lead chromate. In all about sixty cases of lead poisoning were traced to the two bakers, with a number of deaths and much serious invalidism. Several bodies were exhumed and I found lead in some of the viscera. I also noted (what is by no means uncommon) the presence of copper in the liver. It is now pretty well known that copper is almost always present in small amounts in the bodies of herbivorous animals from which it may readily enter the human system. It also seems that minute amounts of copper may be beneficial in promoting the nutritive function of iron. The result of these "chrome yellow" cases was the conviction of the two bakers and the noodle maker under the general law against adulteration of food and the sentencing of them to terms in jail. The publicity given to the matter terminated forever the use of the material as a substitute for eggs. Yellow colors somewhat of the nature of those used for butter-colors (noted below) were employed to take the place of the lead salt. These colors were also largely used at one time for coloring oleomargine, but this has been prevented by the Federal law which imposes a heavy tax on artificially colored butter-substitutes.

A new storm center grew out of the use of these colors. Their high coloring power and brilliancy led to prompt use of them in place of the old-fashioned animal and vegetable colors. Anilin red took

the place of carmine; a benzene derivative known in trade as "butter-yellow" took the place of the annatto, turmeric and carrot-colors formerly used by farmers. A firm in New England devised a mixture that was very satisfactory for butter-coloring. It was composed of some of the oil-soluble, water-insoluble colors known in trade as "Sudans," a mere fanciful title given probably because at the time of the first production, international questions regarding the control of the Sudan by certain European nations were actively discussed. These were marketed, dissolved in a bland fixed oil. On adding a small amount to a large volume of cream and churning, all the color would go into the butter and the buttermilk would be colorless.

Much pulling to and fro by manufacturers and dealers on one hand and state and national authorities on the other occurred before some definite standards were adopted for use of colors, coloring of candies being, of course, a most important phase. At the present time these questions have reached a comparatively quiet state. The use of saccharin and other synthetic substitutes for sugar, and of yellow coal-tar colors as substitutes for eggs, gave food authorities much trouble, but the bulk of this began after I had left the service of the state and Dr. LaWall will have to take up the story here. He can also relate some interesting discoveries made by that active and faithful but erratic detective of the State Food Department, Mr. Cassidy, among which was the discovery of the use of rotten eggs by bakers in the southeast section of the city, in making of what were sold as "kosher" cakes.

The adulteration of spices was very common and flagrant. Being mostly rather costly, the temptation to add cheaper material was great. Pepper, nutmeg, mace and other less known condiments were largely adulterated with almond shells and similar inert material. Cream of tartar was also an object of great sophistication. Powdered alum was sold for such purpose under the title C. T. S. (cream of tartar substitute). Within recent times chemists have been arraigned in opposition concerning the propriety of calling sodium aluminum sulphate, "sodium alum," but the studies of Mr. Strock and myself seem to have decided that question in the affirmative.

Looking back over my work in these lines and viewing the present conditions, I confess to a somewhat pessimistic feeling. While I have not made any tests for many years, I have kept in fair touch with the publication of the U. S. Government, termed "Notices of Judgment." These are issued irregularly, the information is often much belated

and the data given in an exceedingly diffuse form. They show, however, constant adulterations of highly objectionable nature, and flagrantly false claims especially in proprietary articles offered as remedies for serious diseases or as cosmetics and fat removers. The unfortunate part of the record in these "Notices of Judgment" is the small penalties imposed. Often the only entry is to the effect that no claimant appeared for the goods and they were ordered destroyed by the U. S. Marshal. Even when penalties are imposed they are usually small fines, which the manufacturer can afford to pay, regarding them merely as a sort of "overhead" or equivalent to a license fee.

Just now the attention of food and drug controllers is fixed closely on the adulteration of cosmetics and on the extensive sale of "hop flavored" malt-extract. New Hampshire under the guide of the State Board of Health and its chemist, Charles D. Howard, and Pennsylvania under the activity of the chemists of the Food Department, including as the Philadelphia official, Dr. Charles H. LaWall, have succeeded in minimizing much of the false branding and misleading labelling of these products, but the Augean stable of fraud is still far from being cleaned.

Those experts who maintain a laboratory for general commercial analysis come in contact with many curious cases, among which those of delusions of poisoning are the most difficult to meet. They are generally men, but occasionally women become subjects of delusion. Men will bring to the chemist fragments of food, a coffee cup containing dregs, or bits of meat and tell a story of pain resulting from eating food at the home table. The delusion is often associated with a suspicion of conjugal infidelity and not infrequently leads to a brutal murder of a wholly innocent wife. Much diplomacy is often required to get rid of the deluded client.

Two curious cases showing the perils of our modern industrial civilization will serve as closing items.

A sharp advance in the European sugar-market caused a cable to be sent to the agents of a steamship then about to take a cargo at a Philadelphia wharf. Orders were given to a refinery to prepare and ship as fast as possible many tons of granulated sugar. This was placed in bags on which had been just printed, in an oil-carbon ink, the proper markings. The bags were loaded while hot into box-cars and on unloading them at the wharf, some bags showed light blue flames around the marking. Evidently, the oil had taken fire spontaneously which is well-known to be a tendency of such material.

Panic, of course, occurred, water was turned on the bags and the cargo was so damaged that no shipment could be made. The trouble was first supposed to be due to the sugar, but it was clearly a case of spontaneous combustion of fatty material.

On another occasion a vessel being about to unload, the hatches were opened and several men descending into the hold, some promptly became unconscious and were dead before they could be removed. One who escaped with only slight trouble stated to me that he noticed no odor nor irritation. It seems probably that through action of the cargo, the proportion of oxygen in the air was greatly reduced or that of carbon dioxid much increased, possibly both conditions prevailed.

I also place on record the fact that on one occasion an engineer of the Philadelphia Electric Company brought into my laboratory a mass of wet material mostly impure caustic soda, which contained small amounts of metallic sodium. The only explanation seems to be that the material, which had been taken from one of the street vaults had resulted from an electrolytic action through some break in one of the supply wires.

The Parr case presented an unusual feature. Parr was convicted of the murder of his daughter under circumstances of great atrocity. Brought to court to receive the death sentence, he was commanded to stand up in the dock, but soon exhibited marked muscular trembling, fell down and tetanic spasms occurred. I did not see these symptoms as the case was not one of poisoning and I was not called. Various methods of treatment were used, among which was the washing out of the stomach with several quarts of water. He died some hours after the attack. The stomach washings were sent to me and I had no difficulty in detecting strychnine therein. The court made an investigation, but no information was elicited as to how the criminal obtained the poison or concealed it. It was interesting to hear the court officers, who had seen the seizure, describe artlessly but vividly the onset of the poisoning—the premonitory muscular trembling deepening to tetanic rigidity. I kept the stomach washings for years and occasionally would take out a portion and put it through the strychnine test, getting clear and definite results, as evidence of the stability of the strychnine molecule.

In the Jennie Cramer case I was consulted but not called. Miss Cramer was an attractive New Haven girl who chose to find disreputable companions—two brothers, sons of wealthy parents and another

young woman of low character. The affair was a brief one, for early in its history, her body was found in the river near the city. The men were arrested and indicted for murder. Expert testimony was given that drowning had not been the cause of death. Dr. Chittenden and his associates made a very extensive, accurate and elaborate examination and found arsenic scattered through the body, calculated as amounting in all to several grains. None was found in the stomach contents and there was no inflammation. Under Dr. Chittenden's testimony the prosecution set up the theory that arsenic had been in solution (such as Fowler's solution, an easily obtained preparation) this having passed rapidly, through the body (like "juice of cursed hebenon") and caused death. In addition to the prominent lawyers engaged by the family of the young men, a rich uncle in another city engaged the services of a lawyer of high ability in practice at the Philadelphia bar and he consulted me several times in regard to the testimony. I could not accept Dr. Chittenden's theory as sufficiently established to make a positive diagnosis of death from arsenic. At that time (the case occurred many years ago) there was a considerable vogue of the use of arsenic as a complexion improver. Preparations for the purpose were sold freely in drug stores. "Dr. Campbell's arsenic pellets" were among these. At one time I had tested them and found appreciable amounts of arsenic. It seemed to me not at all impossible that the young woman, in view of her tendencies, might have been taking some article of this kind and thus introduced into her system a small amount of arsenic. The men were acquitted, for the facts brought out at the trial were not sufficient to justify a conviction of murder in the first degree and there was of course no other degree of crime to be considered.

In this case as in many others the decision of arsenic poisoning has been influenced by a case frequently quoted in the toxicologies to the effect that about two grains of arsenous oxid have produced death. Dr. Witthaus, however, examined the original record of this case (reported many years ago in England) and found that it is entirely untrustworthy as a datum. The amount of poison taken is not absolutely certain and other conditions indicate that arsenic may not have been wholly responsible for the death.

The Deering murder. I include this on account of the unusual experience to which it led. The Deering family occupied a farm in the low, flat land in the southeastern part of Philadelphia, known as

"The Neck," mostly occupied by truck farms and piggeries. Several winding streams and sluices contained a turbid water in which here and there a water lily of imposing appearance grew—a species of lotus, *Nelumbo lutea* Pers. A farm hand, Anton Probst, murdered the whole family. He was caught a few days later, convicted and sentenced to be hanged. The incident occurred in the late '60's, when I was a student at Jefferson Medical College. About that time much interest had been aroused over the use of electricity in the treatment of disease, and portable apparatus for producing electrical currents of fairly high voltage and very low coulombage—therefore safe—were much used. Also, it had become known that shortly after death the muscular system would respond to electrical stimulation. One of the Jefferson professors was physician to the prison, and the convict had no relative or friend, his body was confiscated by the State and it was decided to make some experiments. Commercial currents were, of course, unavailable, so a large number of voltaic cells were taken to the prison and set up ready for the addition of the acids. James M. Barton, then a student, assisted me in the work. We were told that persons under age were not allowed at executions, but incidentally that the gallows was already set up in the prison yard. It was about dusk when we finished our task and we were escorted by the superintendent to the gallows and both Barton and I walked up the ladder and stood for a few moments on the trap, certainly a somewhat unusual experience.

Professor Rand, who conducted the experiments on the body, told me that they were quite successful, various grimaces and other muscular movements having been carried on for more than hour after the body had been taken down.

THE ELECTRONIC STRUCTURE OF ORGANIC COMPOUNDS

By Ingo W. D. Hackh

THE MODERN concept of atomic structure is beginning to enlighten us in the century-old problem: "What holds the atoms in the molecule together?" Affinity, attraction, electric force, valency, bonds, or the illustrative hooks or hands were and are some of the terms used to describe the phenomenon of chemical bonds or linkage between the atoms. To be sure our modern picture of the forces (electromagnetic in nature) holding the atoms together is not completely finished; science approaches, never reaches, the first cause. Nevertheless we can formulate some theory as to the nature of these chemical bonds by which we may predict the behavior of the compounds.

The organic chemist chooses the tetrahedron as the geometrical form of the carbon atom, for this form explains stereo-isomerism, cis- and trans-isomerism, triple bonds and related phenomena. The modern physical chemist likewise prefers the tetrahedral shape for all atoms. The cubical atom of Lewis merges, according to him, into the tetrahedral atom merely by drawing the electrons together, so that

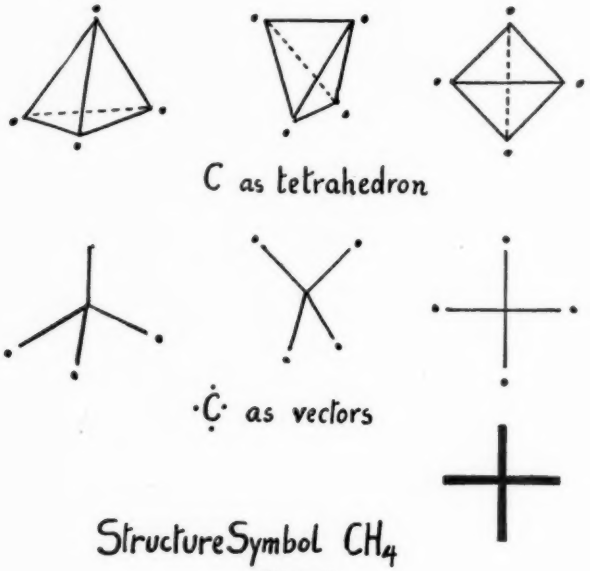


Figure 1

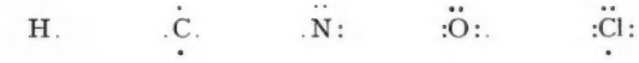
the eight electrons situated at the corners of a cube, become four electron pairs, situated at the corners of the tetrahedron.[1]

Naturally no one today conceives of this tetrahedron being solid and although we draw geometrical figures, we realize that the atom is empty, save for the minute nucleus and the surrounding electrons. The tetrahedron represents, so to speak, a field of force, with the corners notating the direction or points of attack. Simpler is it perhaps to picture the tetrahedral atom by four vectors running from the center to each of the four imaginary corners. Still more conventionalized is the structure symbol [2] which pictures the carbon atom in the position of a tetrahedron looked upon edgewise and perpendicular to the edge. In figure 1 these three methods of representing the carbon atom are compared by illustrating the carbon atom in different positions and indicating the valence electrons by a dot.

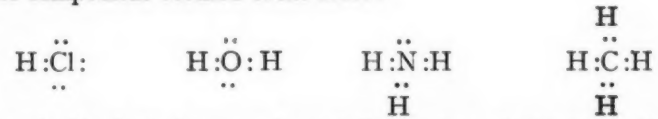
The valence electrons are thought to be responsible for the bonds; in fact many properties of the atoms are traced back to them. Their number may be from one to eight, according to the position of the element in the periodic system. The atoms concerned mostly in organic compounds are

hydrogen (and alkali metals)	with	one	valence	electron
carbon (also Si, Pb, etc.)	"	four	"	"
nitrogen (also P, As, etc.)	"	five	"	"
oxygen (also S, Se, etc.)	"	six	"	"
chlorine (also Br, I, etc.)	"	seven	"	"

According to the Lewis theory each atom (except hydrogen) is normally satisfied whenever surrounded by an octet, that is four pair of electrons. In a compound this number eight is normally reached by sharing the necessary electrons with other atoms, each "pair" constituting a bond whenever each of the two atoms has contributed one electron to the pair. Thus in the Lewis notation the normal atoms are



and the compounds formed from these:



Oxygen is bivalent, because it contributes two electrons to the two

pairs which are shared with the hydrogen; carbon is tetravalent because it contributes all four electrons to the four electron pairs.

Considering carbon-carbon bonds we may illustrate the single, double and triple bonds between the carbon atoms as follows:

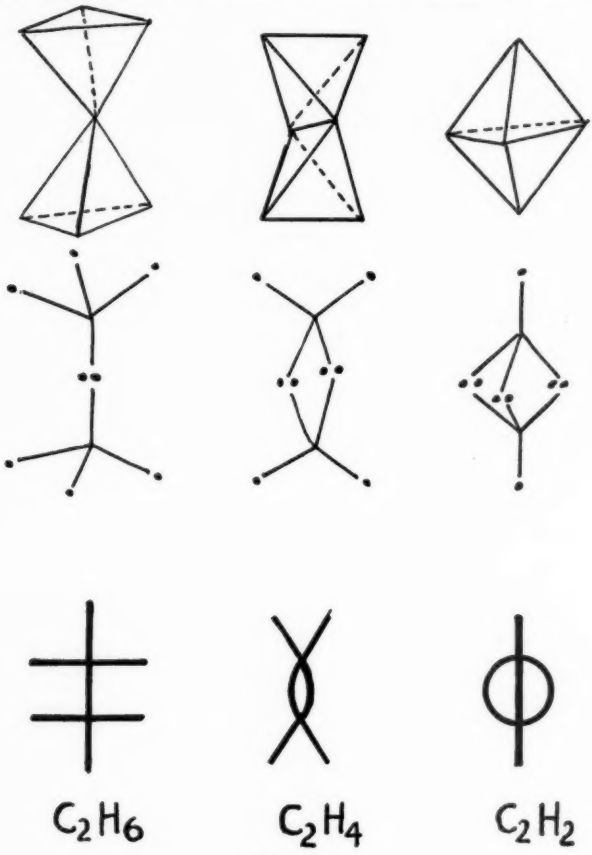


Figure 2

In these comparative figures only the electrons of the carbon atoms are shown, they would correspond, with the exception of the structure symbols, to $-\overset{|}{\underset{|}{C}}-\overset{|}{\underset{|}{C}}-$ $\rangle C = C \langle$ and $-C \equiv C-$. We shall now focus our attention upon the electron pair which constitute a "bond" and consider their motion and their position.

As to motion we have evidence that these two electrons are not at rest but describe an orbit. Electrons in a circular orbit, that is an "electron ring," has magnetic moment and constitutes a Bohr magneton. This may attract the two nuclei, but their positive charge will be repulsed by the negative charge of the electrons. Nevertheless this electron ring keeps the two nuclei in a definite position. The phenomen of excitation and irradiation require that these electron pairs have larger or smaller or more elliptical orbits, thus changing slightly the position of the nuclei to each other. It is very probable that living protoplasm, the living matter of the cells, consists of excited molecules; that is molecules in which the electrons are in excited orbits.

As to position we find that the electron pair may shift more to one than the other atom, the atom which it approaches becomes more electronegative, the other atom more electropositive. Hence the term polarity. A typically non-polar bond is one in which the electron pair

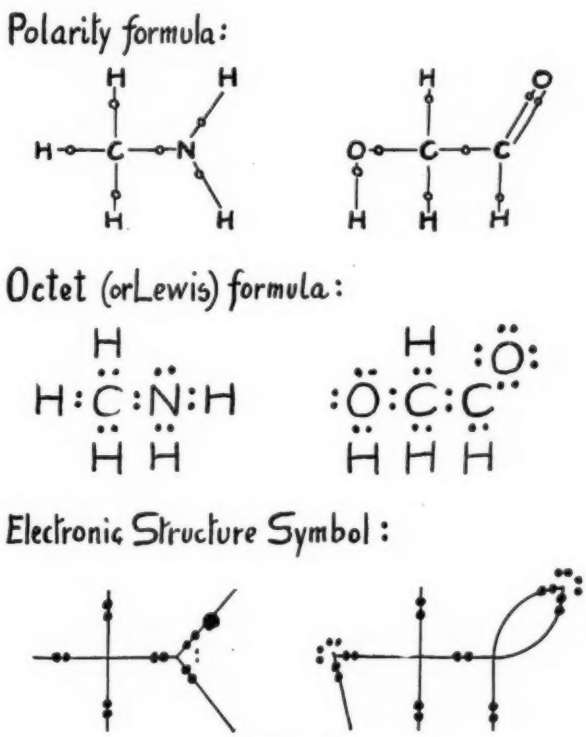


Figure 3

is shared equally. A polar bond is one in which it is shared unequally. This shift of the electron pair has been depicted in various ways by the distance of the dots or circles indicating the electron pair, thus

A.....:.....B or A.....o.....B
A.....:.....B or A.....o.....B
A....:.....B or A....o.....B
A..:.....B or A..o .....B

where the electron pair shifts more and more toward A, hence A becomes more and more negative with respect to B.

The Lewis formula gives us the number of electrons, the polarity formula shows the relative distance, that is the negativeness or positiveness of the atoms concerned and the electronic structure symbol combines the advantages of both notations, thus:

In the structure symbols the dots upon a line indicate the electrons which are shared and constitute the bond, those which are not shared surround the particular atom.

This notation may at first sight appear complicated, but will lose its complexity by assuming as fundamental principle the postulate: The electron pair constituting a bond will shift toward that atom which has the largest number of unshared electrons. Thus the shift will be greatest toward the halogens, next to oxygen, less to nitrogen, and not at all to carbon or hydrogen.

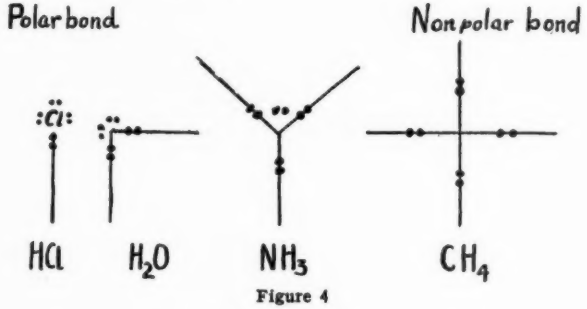


Figure 4

Thus carbon-carbon, and carbon-hydrogen bonds are truly non-polar; provided, however, that there are no adjacent radicals or atoms which will disturb this polarity. Between non-polar and very polar compounds we may have any number of transitional compounds which will vary slightly in polarity. The extreme of every polar bond is

reached when the bond "breaks" and the atoms become ions, that is the complete transfer of one electron from one atom to the other.

The construction of such an electronic structure symbol is perhaps best illustrated by indicating the various steps on a few examples. Let us take ethane, methyl alcohol and acetic acid:

(A) Write the structural formula, Fig. 5a.

(B) Construct the valence skeleton by eliminating the symbols for C, H, O, and N, Fig. 5b.

(C) And obtain thus the structure symbol, Fig. 5c.

(D) Add the valence electrons, Fig. 5d, by placing a dot on each line near the atom so that each line has now two dots corresponding to the pair of electrons, one from each atom.

(E) Add the unshared electrons, Fig. 5e, so that each atom, except hydrogen, is surrounded by *eight* electrons, which may or may not be on the lines; hence carbon with four lines has all eight electrons, nitrogen with three lines has six electrons shared and received two electrons outside the line, oxygen with two lines has four electrons in the shared electron pairs and receives two more pairs outside the lines; chlorine with two electrons shared, receives three pairs which are not shared. This figure now shows the proper number of valence electrons, shared and unshared, and corresponds to the Lewis formula.

(F) Indicate the shift of the electrons, that is the polarity, by drawing the electrons nearest to the most negative atom, that is the one with the greatest number of unshared electrons, that is in the order $Cl > O > N$, while $C = H$. The finished electronic structure symbol is now as shown in Fig. 5f.

This final picture of the electronic structure should now indicate that:

(1) In ethane there is a truly non-polar bond; all of the six hydrogens are neither positive nor negative and hence not readily replaceable by positive or negative radicals or atoms.

(2) In ethyl alcohol the oxygen has drawn the electrons around it, making the alpha-carbon more positive, and the hydrogen of the hydroxyl group likewise positive, that is replaceable by positive radicals or atoms. The hydrogens on the alpha-carbon are slightly negative, replaceable by negative radicals, those on the beta-carbon slightly positive.

(3) In acetic acid the two oxygen atoms have made the carbon atom still more positive, likewise the hydrogen of the hydroxyl

group is very positive, most easily replaced by positive radicals or groups (*e. g.*, esterification, neutralization) while the alpha-carbon has become slightly negative.

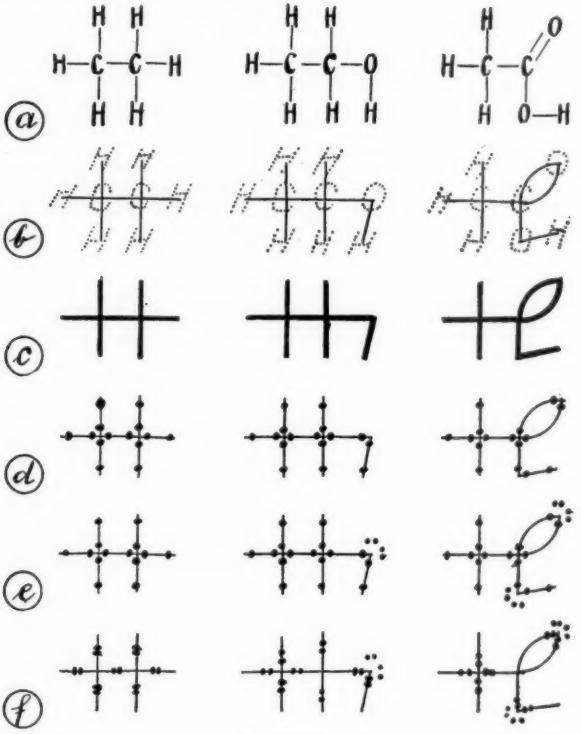


Figure 5

In a similar fashion the probable substitution of hydrogen in the benzene ring can be predicted. Fig. 6 shows the neutral benzene molecule. All hydrogens are of equal polarity. If, however, one hydrogen is replaced by a negative radical, Fig. 6b, then the second negative radical will select the meta-position, the third negative radical the symmetric position, that is will form substitutes 1, 3—and 1, 3, 5—substitutes. A positive radical, however, will take the ortho- or para-position, that is form 1, 2—or 1, 4—substitutes. If, on the other hand, a hydrogen is replaced by a positive radical, Fig. 6c, the reverse will take place, that is an additional negative radical will choose the ortho- or para-position, and an additional positive radical the meta-position.

The study of electronic structures of organic molecules and the polarity of these compounds is still in its infancy, but the writer believes that this notation will aid in forming some visual concepts of the underlying principles and he invites criticism and discussion.

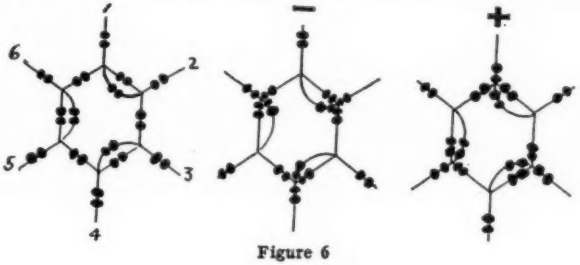


Figure 6

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THE PHARMACOPŒIA*

By E. Fullerton Cook

*Read before the Pennsylvania Pharmaceutical Association, June, 1930.

THE ENEMIES of the principles of democracy must have smiled when early in May the delegates to the Eleventh Pharmacopœial Convention assembled in Washington and passed through a convulsive ordeal which all but wrecked that supposedly dignified and matured organization.

In miniature all phases of those tragic stages of disintegration were experienced which destroyed Rome and Venice and which leads the historian to predict that no democratic form of organization can survive the domination of an ambitious or a selfish minority.

Fortunately the Pharmacopœia came through, but it will take a long while to restore the vigor and strength of the past decade for, as one experienced and thinking physician said, "The mutual confidence of medicine and pharmacy, resulting from twenty years of cooperation, was seriously shaken."

A panoramic review of the Pharmacopœial Century makes the last Convention particularly tragic. The medical profession started the Pharmacopœia over a hundred years ago. Constantly, during the pre-convention period, the ideals of that small group of early physicians were quoted as classic policies for our current Revision. Such principles as "A Pharmacopœia must represent the best thoughts of its day," and "Delegates to the Pharmacopœial Convention must be gentlemen, willing to serve, men distinguished for their ability and learning," have demonstrated themselves essential truths which must prevail if our method of revision is to continue.

Though of medical origin, after twenty years a group of pharmacists, also idealists and lovers of their profession, voluntarily offered the physicians the results of their most arduous labors and their revision became the 1840 Pharmacopœia.

Mutual respect and professional confidence being established, the physicians invited the pharmacists to become equal partners in the preparation of the 1850 Pharmacopœia and for eighty years this plan has prevailed.

Again in 1930 the physicians said, "We have every confidence in the ability and integrity of our pharmacist friends; we are entirely willing that they shall have full control over every phase of the revision work which is pharmaceutical; we naturally ask that the pharmaceutical profession shall have equal confidence in our ability and integrity and give us the same opportunity to decide purely medical questions and, with the physicians and pharmacists working together in mutual confidence, each performing his own duties energetically and ably, an acceptable Pharmacopœia is assured."

In answer to this friendly offer from medicine, one pharmacist stood on the floor of the Convention and said: "I claim that the committee of sixteen physicians have not sufficient confidence back of their recommendation to the whole committee to convince our committee that we elected for this very purpose that their contention is correct, then that committee ought to have the right to go outside the drugs recommended by the physicians and put their drugs in the Pharmacopœia. I believe we are making a great mistake in going on record as relegating one particular line of work and one particular decision to any one body of men, and I doubt if the members of the Revision Committee who represent the medical profession would contend before this Convention or before the Revision Committee that they truly represent the consensus of the opinions of the phy-

sicians of this country as to what drugs represent the true therapeutic value. I do not believe that we should concentrate this matter too much in the hands of a few men and leave it to the physicians to suggest and recommend to the Revision Committee that we depend upon for final action to make final decision on this question." Is it surprising that this was resented by many?

The chief promoter of this policy was repeatedly quoted as saying to pharmaceutical groups during the past two years, "Do you want the doctors to dominate you?"—a wholly unjustified appeal to prejudice and class domination.

Another group, active politically for several years before the Convention frankly said in print, under the heading "When the U. S. P. is Revised Pharmacy Must be Strong" *:

> "The cough syrup, liniment, lotion or other preparation fabricated by the retail druggist in his back room and sold by him over his counter for self-medication is a property right. . . . and a hundred other well known products, all started in the back room of a drug store and won their first public recognition and acceptance as remedial agents, in a drug store.
>
> "History repeats itself.
>
> "Some of the famous drug store sellers of 20 years hence are now passing through their babyhood stage in the drug stores of the United States. Hence retailers have a deep interest in this effort to restrict products for self-medication, aside from the present sale of such products. In the mintage of time, undue hostility to self-medication may pinch retailers where it hurts. They may have a big seller of their own in the cocoon and on the way.
>
> "Drug Trade interests are concerned over this threat and it is said are not willing to let the situation get out of its hands—not yet.
>
> "What many men prominent in pharmacy fear is that, unless properly held down, certain influences may seek, through revision of the next Pharmacopœia to exclude many drugs heretofore recognized in that standard work.
>
> "In this connection, pharmacists and manufacturers say it must not be forgotten that the U. S. P. is a legal standard as well as a list of certified therapeutic agents.
>
> "With the exclusion of these drugs from the Pharmacopœia, attacks on products containing these drugs will have more force than they would have if the Pharmacopœia recognized them. It can be maintained that they are not official, and not in line with modern scientific recognition, though some have been used with beneficial results for 100 years.

**Drug Topics*, June, 1929, page 192.

"Retailers using these excluded drugs in the manufacture of their own store preparations will be weakened in their position if they are eliminated, in the event of any necessity to defend their use of them.

"Manufacturers will be in the same vulnerable position with respect to packaged preparations sold by retail druggists, if similarly attacked.

"The importance of this danger may be realized and evaluated, it is stated, if it will be remembered that certain schools of medical opinion hold that not more than 15 vital drugs are essential to medicine for the treatment of the various types of human debilities.

"This, of course, is drawing the line rather sharply. It is not believed that any general wholesale elimination will be attempted. Every Pharmacopœial convention makes certain changes. This is expected in the light of improved scientific research and enlarged knowledge. What pharmaceutical interests wish to guard against is that the knife will not be used for excision purposes more freely than justified by scientific requirements and that commercial considerations will not be allowed to creep into the work of revision as part of a general scheme of warfare on self-medication.

"If pharmacy which has a commercial as well as a scientific interest in the preservation of recognition for useful drugs by the Pharmacopœia is properly represented by delegates at the U. S. P. convention, whatever influence any one may attempt to exert to the disadvantage of the druggist, can be held within reasonable checks it is said.

"That is all pharmacy wants. The power to do this is within the grasp of pharmacy if its delegates are on hand.

"In the interest of pharmacy, they should be on hand. Elect them at your next state convention."

These two groups combined at Washington under aggressive leadership to dominate the Convention and the two leaders both boasted openly then and still boast that they controlled enough votes to do anything they pleased at the Convention.

One has since said that he refrained from using his power because he saw that to do so would have caused the physicians to leave the Convention in a body and thus have wrecked the Pharmacopœia and is now proud of having saved the Pharmacopœia. But it is more likely that had not these two leaders withdrawn at the time they did they would have been swept from the Convention by the wave of indignation which had arisen over their conduct.

The real leaders in America's professional pharmacy were aroused from coast to coast and with militant spirit were ready, if it had been

necessary, to crush this unworthy attempt to seize power by political manipulation. By the second day of the Convention many men discovered the character of the movement, and had lined up with the opposite pharmacy forces working for the real interests of pharmacy.

In this is the justification for our faith in the future. How can professional pharmacy look to any progress if it does not find it in an harmonious cooperation with the scientific and able developments of the medical sciences? Are we going to allow the "patent medicine" interests or politicians working for their own power to lead American pharmacy? To ask that question is to answer it, for our pharmacy group is essentially sound, its scientific work is brilliant and promises to reach in this decade, an elevation of which we may all be proud, and which is certain to receive recognition from every branch of the medical sciences.

For pharmacy to come into its own it does not require political power, it needs but sound, able and honest scientific accomplishment and it will receive recognition just to the degree to which it delivers meritorious service in the interest of public health.

There was another unfortunate misunderstanding in the Convention which must be corrected. The Committee of Revision had given much careful thought to the "General Principles" to be submitted for the consideration of the Convention. In other decades these "General Principles" were drafted at a meeting of the Committee on the day before the Convention when usually about half the Committee were present. This year they were made the subject of a day's consideration, in personal conference, of the Executive Committee, six months before the Convention and were then, as revised, placed before the General Committee for discussion in the Circulars and again taken up by that Committee, in personal conference in Washington on the Monday before the opening of the Convention. Each paragraph was carefully studied and finally unanimously approved by the Committee.

Dr. Henry H. Rusby expressed great interest in these "General Principles" and, although not a member of the Committee, to be entirely fair to Dr. Rusby, the Chairman mailed to him, about ten days before the Convention, a copy of the proposed "General Principles." This, in part, explains why Dr. Rusby was ready to make many amendments in the Convention but also makes more reprehensible his ignorance concerning the history of the fifth paragraph which read as follows:

"*Standards for Purity and Strength.*—It is recommended that the Committee of Revision be instructed to provide standards of purity and strength for Pharmacopœial substances for which limiting tests are or may be given. While no concession should be made toward diminution of medicinal value, an allowance may be made for *unavoidable innocuous impurities, or variations* due to the particular source, the mode of preparation or the keeping qualities of the several substances.

"The 'Purity Rubrics' should be continued and tests and requirements should be provided for each substance for which a 'Purity Rubric' is given."

With reference to this paragraph, Dr. Rusby said in the Convention (from the stenographic report), "I think it is a monstrous proposition. I think that if this Convention ever lends itself to that or lets this thing get through they will become a by-word of every civilized country on the globe, for leaving out this important provision and putting in this, which is nothing—I do not accuse the membership intentionally—but it is nothing more or less than a provision for adulteration. That is all it is."

Again, two weeks later at the Rusby-Ambruster hearings in Washington, before the Senate Committee on Agriculture, Dr. Rusby says (from the stenographic report):

Senator Copeland: "Do you (Dr. Rusby) say that an effort was made on the floor of the Convention to lower the standards (of the U. S. P.)?"

Dr. Rusby: "To leave out these standards."

Senator Copeland: "Who were the persons who made that demand?"

Dr. Rusby: "That came from the Committee of Revision composed of fifty people, but from whom in the Committee on Revision I do not know. I was not a member of that Committee."

Senator Copeland: "Do you mean that the Committee on Revision made that recommendation?"

Dr. Rusby: "Yes, sir."

Senator Copeland: "To lower the standards?"

Dr. Rusby: "I charge now that that is the result of this conspiracy which has been going on, which has extended rights into the Committee of Revision."

The absurdity of these charges by Dr. Rusby is made evident when your attention is called to the fact that the clause which Dr. Rusby attacked in the Convention, and which he demanded should

be changed, was the same clause, word for word (except the introduction of the word "may" for "should," a change which would rather increase than diminish the quality) as had been adopted by the Pharmacopœial Conventions in 1900, 1910, and 1920, with no recorded objection and with no subsequent diminution of the quality of medicinal substances.

Dr. Rusby, himself, was a member of the 1900 and the 1910 Pharmacopœial Conventions and also a member of the 1910 Committee of Revision and at no time, during thirty years in which it was in operation, registered any objection to it with the Committee of Revision.

That the purpose of this clause may be fully understood, a word of explanation may be necessary. Every Pharmacopœial substance for which a satisfactory assay method is available, carries what has come to be known as the "Purity Rubric." This is a concise statement of the degree of purity required. For instance, under Potassium Bitartrate (cream of tartar) the Purity Rubric reads "Potassium Bitartrate, when dried to constant weight at 100° C., contains not less than 99.5 per cent. of $KHC_4H_4O_6$." Now the clause objected to by Dr. Rusby was intended to permit here the presence of 0.5 per cent. of *unavoidable, innocuous substances,* the exclusion of which might greatly and wholly unnecessarily increase the cost of the product. Note that the text which follows rigidly excludes all *dangerous impurities,* such as lead, copper, zinc, arsenic, insoluble substances, etc., and in the opinion of the Committees of Revision and of the Pharmacopœial Conventions for thirty years, it was considered unnecessary to penalize the sick by demanding one hundred per cent. purity for medicinal substances when the final, costly purification processes would add nothing to the therapeutic value but would tremendously increase the cost of medicines.

This principle was proposed and discussed publicly many times by the late Chairman, Joseph P. Remington, and has been explained during the past year by the present Chairman in an address which has been published in a dozen journals and of which three hundred copies were distributed at the recent Pharmacopœial Convention.

This wholly unnecessary agitation and discussion was brought into the Convention by Dr. Rusby's misinterpretation of paragraph 5 of the "General Principles." The fallacy of his claim that "he had saved the country from a conspiracy within the Committee of Revision itself, a conspiracy to break down the high standards of the Pharmaco-

pœia, by his insisting upon the inclusion of the paragraph found in the general standards of the U. S. P. X, is shown by simply reading that clause. This clause says that "Official Preparations are to be made only from drugs that conform to the Pharmacopœial standards, definitions and descriptions." So it will be seen that the new sentence demanded by Dr. Rusby still leaves it to the Committee to set the standards as they please and, if they were the kind of conspirators, implied by Dr. Rusby's charge, they still have it within their power to set low standards within the texts themselves.

Delegates Hereafter Must Be Truly Representative—One of the main foundations for the political activity of the recent U. S. P. Convention was the filling up of delegations by representatives not even remotely connected with the institutions by which they were named.

The appointment of such delegates was a part of the scheme adopted by those posing as the political leaders of the Convention, and although the delegates were all supposed to be registered sixty days ahead of the Convention, by the request of the Convention itself, one of these leaders was busily offering delegateships to those who would promise to vote for his candidates up to the very day of the Convention.

There can be no question but that this, in principle, is wrong. The district representation was established, as in Congress, that, in this our large and democratically organized country, every part of it should have an opportunity to speak and vote for itself. To have it used to pack the Convention for special interests was unscientific and unethical and should never again be tolerated.

A provision, removing this possibility, should be demanded by the next Convention.

Publish Complete List of Delegates at Least Thirty Days Before the Convention—A valuable aid to the organization of the Convention and a means whereby most of the objectionable political activity of the last two Conventions could be eliminated would be the final closing of the registration of delegates at least thirty days before the Convention and the publication by the Credentials Committee of the complete list. If everyone knows that the registration closes finally on a widely announced date no injustice will be done. The advantages of this plan for the assuring of correct representation in the Convention is self-evident.

Members of the Committee Should Qualify—A third reform which seems appropriate would be the requirement that nominations for membership on the Committee of Revision shall be made in writing, on a form supplied by the Convention officials, the nomination to include a statement of the special qualifications of the nominee. It should also be permissible for the Convention to select eminent medical or pharmaceutical scientists, who would be willing to serve on the Committee, whether they be present at the Convention or not.

These nominations should be printed and distributed at the Convention before the election of the Committee.

These three reforms, it is believed, would result in the avoidance of many of the objectionable characteristics of recent Conventions and always insure a creditable Pharmacopœia.

The U. S. P. XI—Notwithstanding the stresses and intense feeling exhibited at the recent Convention, the officers, Board of Trustees and Committee of Revision finally elected are representative scientists in both medicine and pharmacy and there is justification for the belief that the U. S. P. XI shall be worthy of our support. With the splendid financial situation which insures more research, with the assurance of international cooperation in many difficult problems, and with an adequate publicity program approved by the Convention there is promise of a new era of Pharmacopœial use and usefulness.

PLANT PATENTS*

By Joseph W. England

ONE OF THE most interesting laws recently enacted by the Congress of the United States is the so-called Townsend Bill (S 4015) providing for plant patents, *i.e.*, the grant of patents to persons who discover or develop a new plant, tubers excepted. It was approved on May 30, 1930.

Section 4886 reads: "Any person who has invented or discovered any new and useful art, machine, manufacture, or composition of matter, or any new and useful improvements thereof, *or who has invented or discovered and asexually reproduced* † *any distinct and new*

*Presented to Pennsylvania Pharmaceutical Association, June, 1930.

†Asexual Reproduction: "If a portion of the stem of a plant, including one or more nodes be placed under suitable conditions of growth, it will form roots and a new plant will be developed. This method is frequently resorted to by horticulturists and is known as asexual reproduction or propagation." (Kramer.)

variety of plant, other than a tuber-propagated plant (italicized by J. W. E.), not known or used by others in this country, before his invention or discovery thereof, and not patented or described in any printed publication in this or any foreign country, before his invention or discovery thereof, or more than two years prior to his application, and not in public use or on sale in this country for more than two years prior to his application, unless the same is proved to have been abandoned, may, upon payment of the fees required by law, and other due proceeding had, obtain a patent therefor."

By the Townsend Act, comments the *Philadelphia Inquirer* (May 27, 1930), "Encouragement and protection are given ingenuity along botanical lines, as had long been the awards to ingenuity along mechanical lines. In passing on the merits of the various claims the Patent Office will have such available information as the Department of Agriculture can furnish. Edison believes farming will be aided by conferring this recognition on plant breeders. He predicts we shall have an abundant crop of Burbanks. The person who grows two blades of grass on the spot where one grew before, Dean Swift said, deserves better of mankind. Evidently Congress thinks so, too."

The intent of the law is to stimulate the discovery and development of new "varieties" of plants, not necessarily new genera and species. We have, at present, mechanical-patents, process-patents for chemical compounds, product-patents, and now, plant-patents; possibly in the future, we may have animal-patents for new breeding or cross-breeding of animals! Who can tell? The law is meant to benefit the farmer, and animal breeding is a most important industry.

But, while the original intent of the law was probably more or less limited in scope, the law, apparently, has wide possibilities of application, and may stimulate an extraordinary development and production of plants, plant-parts and plant-products.

What *is* a plant?

A plant may be defined as any member of the vegetable kingdom, and a "variety" of a plant, botanically, is a subdivision or peculiar form of a species; and this embraces a whole world of vegetable organisms; the humble and lowly common white potato—"a tuber-propagated plant"—is excepted under the law. And, the term embraces, also, bacteria of all kinds, including pathogenic bacteria, since "bacteria are one-celled plants of microscopic size and various shapes" (Kraemer). So it would seem to be within the range of possibility

that, some day, a bacteriological Burbank may grow bacteria under suitable conditions and produce new varieties or strains. Think of what will happen, then, if a research worker discovers a new variety of bacteria whose antitoxin is a cure for all types of pneumonia, and patents the organism for seventeen years, thereby controlling all the antitoxin made therefrom! Or, discovers a new organism whose antitoxin cures diphtheria! Or, discovers one whose antitoxin cures typhoid fever, or antitoxins for other infectious diseases!

Or, visualize what will happen if some Burbank discovers a new variety of cinchona tree that will yield 10 per cent. of quinine, or a poppy that will yield 15 per cent. of anhydrous morphine, or a nux vomica that will yield 5 per cent. of strychnine, or an ipecac that will yield 3.5 per cent. of ether-soluble-alkaloids, or a camphor tree that will be so rich in its "dextrorotatory ketone" that it will eliminate synthetic camphor from the market! Or, discovers "varieties" of digitalis, some containing only digitoxin, and some only digitonin. Or, grows plants to fit special diseased conditions! Why, as Colonel Mulberry Sellers said of his eye lotion for the Chinese—"there's millions in it!"

The Townsend Act is primarily intended to help the farmer (and horticulturist) but if the farmer, why not the pharmacist—pardon the pun! If the farmer can have patent protection on new "varieties" of plants, why not the pharmacist on new "varieties" of preparations of plants?

But, all jesting aside, the granting of plant-patents is a most important step forward in patent legislation and may lead to important and far-reaching developments in the cultivation of medicinal plants in this country, as well as abroad, although, of course, the fanciful possibilities of development above suggested are exceedingly remote and unlikely.

MEDICAL AND PHARMACEUTICAL NOTES

FIVE HUNDRED TONS OF ASPIRIN A YEAR—Deaths from poisoning by aspirin are on the increase in England and Wales according to the Statistical Review of the Registrar-General. This is not surprising in view of the quantities of the drug (500 tons a year, according to Dr. Dishington) consumed in Great Britain. The significant fact is that there has been a big jump in aspirin fatalities. In 1927, five people met their deaths, by intent or accident through taking aspirin, while in the year before there was no recorded case. In 1928 the number was seventeen—ten accidents and seven suicides. That there is a moral to draw from these figures is obvious.—(*Pharm. Jour.*)

"ADMINISTER" AND "DISPENSE" CONSTRUED—In the State of Washington it is unlawful for any person to sell, furnish or dispose of, or have in his possession with intent to sell, furnish or dispose of, any narcotic drug, except on the written prescription of a physician and except that wholesale dealers in drugs may sell narcotic drugs to other wholesale dealers, retail dealers, physicians, dentists and veterinarians. It is unlawful for any person to have in his possession any narcotic drug, except certain exempted preparations of such drugs, unless it has been obtained in compliance with the narcotic law of the State of Washington and with Federal narcotic laws. Proof of the possession of any narcotic drug, except by a licensed physician, licensed manufacturer or licensed druggist, is *prima facie* evidence of an intent unlawfully to sell, furnish or dispose of it.

The defendant was convicted of having unlawful possession of narcotic drugs and of the unlawful possession of such drugs with intent to sell them. She appealed to the Supreme Court of Washington. The published decision of the court does not show that the defendant affirmatively claimed that she had obtained from a physician the narcotic drugs found in her possession, although such a claim may be inferred from the language of the decision. The State law provides that any physician registered under Federal narcotic laws may "administer" narcotic drugs for legitimate medical purposes, in

the course of his professional practice, in quantities proportioned to the needs of his patient. *Ibid.* On behalf of the defendant it was contended that the provision allowing a physician to "administer" for legitimate medical purposes allows him, if acting in good faith, to deliver to his patient narcotic drugs to be taken away and used in the future. Under such a construction of the law, if the narcotic drugs in the possession of the defendant had been "administered" to her by a physician, her possession of them might have been lawful.

Under the Washington statute, said the court, there are only two ways by which a patient may lawfully get possession of a narcotic drug; namely, by having it "administered" by a physician or "dispensed" to the patient by a druggist on a physician's prescription.* *A physician cannot lawfully "dispense"; a druggist cannot lawfully "administer."* The legislature seems to have used the word "administer" in the sense that the drug shall be taken by the patient at once, under the immediate direction and supervision of the physician. It seems to have used the word "dispense" to mean that the drug shall be delivered to the patient by the person filling the prescription, to be taken away for future use. This corresponds with the common understanding of the word "dispense." When the statute speaks of a physician using the drug for legitimate medical purposes in the course of his professional practice it does not use the word "dispense"; the word "administer" is employed. The physician can give what is needed for present use, while such as may be needed in the future, if any, must be provided by means of a prescription, to be filled by one who dispenses the drug. The interpretation of the statute, said the Supreme Court, was adopted by the trial court, and the instructions by that court in accordance with it were correct. The judgment of the trial court was therefore affirmed.—(*Jour. A. M. A.*)

GINGER PARALYSIS CAUSE DISCOVERED IN PHENOL COMPOUND—A substance related to carbolic acid is probably the adulterant which caused thousands of cases of paralysis from drinking Jamaica ginger last February and March.

A phenol compound, probably the phosphoric acid ester of tricresol, is the substance which Dr. M. I. Smith of the U. S. Hygienic

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*EDITOR'S NOTE: The italicized sentence is one which deserves careful consideration, particularly since it appears so rarely in *medical* literature.

Laboratory, working with the Prohibition Bureau, found in samples of the ginger from shipments that had caused cases of the paralysis. Samples from shipments thought but not definitely known to have caused paralysis, also contained this substance. Samples from lots that did not cause paralysis did not contain any of the phenol compound.

Samples from the first two classes of shipments were fed to rabbits, monkeys and dogs. The monkeys and dogs were not affected, but the rabbits became paralyzed in the limbs and died of respiratory failure.

An adulterated fluid extract of ginger was made in the laboratory to resemble the ginger that had caused the paralysis outbreaks in human beings. This extract contained tricresol phosphate, the suspected compound. It had the same effect on the animals as the samples of the ginger which were known or thought to have caused the human disease.

The government scientists were at a loss to explain why the monkeys and dogs were not affected by the ginger samples, but they found that paralytic symptoms could be produced when the suspected phenol compound was broken down chemically before being given to the dogs and monkeys. This suggested that the compound passed through the stomachs of these animals unchanged, while in the stomachs of rabbits and of man it was broken down into a poisonous substance.

No explanation is made of the source of this adulterant or contaminant. Possibly it occurred as a denaturing agent on the illicit alcohol used in the preparation.—(*Science Service.*)

New Anæsthetic for Use in Eye Surgery—Successful use of the new anæsthetic, avertin, in certain kinds of eye operations is reported by Dr. W. H. Wilmer of the Johns Hopkins Hospital and University in a communication to the American Ophthalmological Society. Avertin is known chemically as tribromethanol. It was developed in Germany by Dr. Richard Willsträtter of Munich and Dr. Duisberg of Jena.

The new anæsthetic has many advantages over ether and is equally safe for certain types of surgery. It is injected instead of being inhaled and is given while the patient is in his bed. He quickly falls into a deep sleep and awakens hours after the operation. The

preliminary period of excitement and nervousness is eliminated, as well as a good bit of the post-operative pain and discomfort. Vomiting is infrequent after awakening from avertin anæsthesia.

From the surgeon's viewpoint avertin has the added advantage of giving thorough relaxation and there is less bleeding. Pulse and breathing rate are only slightly changed and the blood-pressure is lowered a little.

"Where general anæsthesia is required, avertin is a safe and valuable addition to the list of drugs used in ophthalmic surgery," Dr. Wilmer said. He pointed out that avertin cannot be used safely where the patients are aged or very weak or when certain diseases are present.

The preparation and administration of the drug require the attention of a member of the hospital staff, either doctor or competent anæsthetist, who must give most of his time to this duty.—(*Science Service.*)

BRAIN HORMONE STIMULATES KIDNEYS—A hormone is secreted by the middle part of the brain which stimulates the kidneys to increased activity, Dr. J. Olivet, of the Augusta Hospital, has recently reported. The hormone is produced by the middle part of the brain, but is ejected when other parts of the brain are irritated.

Some time ago it was observed that irritation of certain spots of the brain, particularly that known as the fourth ventricle, stimulated the kidneys and produced a strong diuretic action. It was believed that this was purely a nervous action, that when the fourth ventricle was irritated a nerve sent a message to the kidneys which increased their activity.

However, it was found that the same result was produced when the kidneys were entirely freed of their nerves. This led to the theory that the messenger from the brain to the kidneys was a chemical and not a nervous one, at least in this case.

Dr. Olivet found that the blood serum of animals that had had their brain ventricles irritated produced the same effect on the kidneys, when injected into other animals, as did direct irritation of the brain ventricle. This he considered evidence that a hormone was at work. The hormone seems to be present not only in the blood serum, but in the urine of the animals.

IODINE FOUND USEFUL AS TOBACCO FERTILIZER—Iodine, which has figured largely as "good medicine" for man and beast during the past few years, now assumes a similar role for plants. Investigations by the Bureau of Plant Industry of the U. S. Department of Agriculture have shown that a small amount of iodine added to the soil produces a better growth of tobacco and an improvement in its quality. But if the desirable quantity is exceeded the effects are injurious, manifesting themselves especially in abnormal thickening of the leaf, off colors, poor keeping qualities and unsatisfactory burning.—(*Science Service.*)

BOOK REVIEWS

BERICHT DER SCHIMMEL & Co., ÜBER ÄTHERISCHE ÖLE REICHSTOFFE USW. Jubiläums-Ausgabe, 1929, and the Annual Report on Essential Oils, Synthetic Perfumes, etc., published by Schimmel & Co., Miltitz near Leipzig, edition of 1928, the latter translated by Roland E. Kremers, Ph.D.

The centenary volume, in German, is a splendid collection of monographs by well-known authorities in the field of essential oils. An excellent historical introduction portraying the progress of this famous house has been prepared by Karl Fritzsche and an equally valuable contribution, by Gildemeister, depicts the progress of analytic methods in the evaluation of the products of this industry. Not all the contents of the volume, however, are historical, for there are sixteen scientific monographs on subjects such as the terpeneless oils, Japanese peppermint oil, etc. Pharmacists and chemists interested in this special field will find this work in common with Schimmel's annual reports, a splendid example of the type of scientific recording which is being done by commercial researchers.

The 1928 report, which is listed above, is, as usual, a noteworthy contribution to the literature of essential oils. It should be in the library of every scientific worker interested in this field. Fritzsche Brothers, Inc., 78-84 Beekman Street, New York, are the distributors.

SUPPLEMENT TO THE GERMAN PHARMACOPŒIA. 5th edition published by the German Pharmaceutical Association. 512 p. Berlin. 10 marks.

The book prepared by Dr. J. Herzog, Director of the Scientific Laboratory of the Hageda, in collaboration with Dr. F. Diepenbrock, both of Berlin; Dr. H. Zoernig, Professor of Pharmacognosy in Basel, and the late Dr. L. Lewin, Professor of Pharmacology in Berlin, represents descriptions, identity and purity reactions of about 1000 crude drugs and preparations, not included in the Pharmacopœia. Some are newly introduced medicines as allival, argochrom, benzylum benzoicum, calcium phosphoricum tribasicum, chloraminum crudum, dijodyl, ephedrine hydrochloricum, extractum senegæ fluidum, neohexal, novalgin.

Many are crude drugs and spices omitted from previous issues of the G. Pharmacopœia, but still needed in the materia medica of today. The descriptions are evidently thorough in the details chosen. We would have liked to see more emphasis on the essential characteristics as the inclusion of more plant and drug chemistry and of microchemical tests would have permitted. Specific directions are also given for the making of numerous preparations.

The monographs are written in the systematic style of the G. Pharmacopœia. The book closes with tabellae of maximum dosages, poisons, narcotics, synonyms, and an index for Latin names and their important synonyms.

In the whole the supplement has the character and purpose of the U. S. National Formulary and aims to serve as an up-to-date, indispensable adjunct to the present G. Pharmacopœia and as a welcome forerunner to the next revision.

ARNO VIEHOEVER.